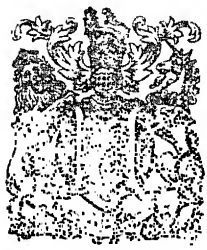
Annual Report of the

Board of Scientific Advice for India

for the year 1907-08



Calcutta
Superintendent Government Printing, India
1909

Price Re. 1 or 1*s*. 6*d*.

Agents for the sale of Books published by the Superintendent of Government Printing, India, Calcutta.

IN ENGLAND

E. A. Arnold, 41 & 43, Madox Street, Bond Street, London, W.
Constable & Co., 10, Orange Street, Leicester Square, W. C.
Bernard Quaritch, 11, Grafton Street, New Bond Street, W.
Deighton, Bell & Co., Cambridge.
H. S. King & Co., 65, Cornhill, and 9, Pall Mall, London.
P. S. King & Son, 2 & 4, Great Smith Street, Westminster, S. W.
Grindlay & Co., 54, Parliament Street, London, S. W.
Kegan Paul, Trench, Trübner & Co., 43, Gerrard Street, Soho, London, W.
B. H. Blackwell, 50 & 51, Broad Street, Oxford.
T. Fisher Unwin, 1, Adelphi Terrace, London, W. C.
W. Thacker & Co., 2, Creed Lane, London, E. C.

ON THE CONTINENT

R. Friedlander & Sohn, 11, Carlstrasse, Berlin, N. W.
Otto Harrassowitz, Leipzig.
Ernest Leroux, 28, Rue Bonaparte, Paris.
Martinus Nijhoff, The Hague.
Rudolf Haupt, Halle, A. S. Germany.
Karl W. Hiersemann, Leipzig.

IN INDIA

Thacker, Spink & Co., Calcutta and Simla.
Newman & Co., Calcutta.
S. K. Lahiri & Co., Calcutta.
R. Cambray & Co., Calcutta.
Thacker & Co., Ld., Bombay.
D. B. Taraporevala, Sons & Co., Bombay.
A. J. Combridge & Co., Bombay.
Radhabai Atmaram Sagoon, Bombay.
Sunder Pandurang, Bombay.
G. A. Natesan & Co., Madras.
Higginbotham & Co., Madras.
Cambridge & Co., Madras.
A. M. & J. Ferguson, Ceylon.
Superintendent, American Baptist Mission Press, Rangoon.
Rai Sahib M. Gulab Singh & Sons, Mafid-i-Am Press, Lahore.
N. B. Mathur, Superintendent, Nazair Kanun Hind Press, Allahabad.
Thompson & Co., Madras.
S. Murthy & Co., Madras.
Temple & Co., Madras.
V. Kalyanarama Aiyar & Co., Madras.
A. R. Pillai & Co., Trivandrum.
A. Chand & Co., Lahore, Punjab.
P. R. Rama Iyer & Co., Madras.
Gopal Narayan & Co., Bombay.

PREFACE.

THE Board of Scientific Advice for India was constituted in 1902, and consisted originally of the heads of the Meteorological, Geological, Botanical, Forest, Survey, Agricultural and Veterinary Departments; but the Government of India intimated their intention to invite from time to time to serve upon it other scientific officers in the service of the Imperial and Provincial Governments, whose special attainments might render their assistance desirable. The Board was declared to be a central authority for the co-ordination of official scientific enquiry, its object being to ensure that the work of research is distributed to the best advantage, that each investigator confines his researches to the subject with which he is most capable of dealing, and that energy is not dissipated by the useless duplication of enquiries or misdirected by a lack of inter-departmental co-operation. It was also hoped that while the claims of abstract science would continue to be recognized in the work of the scientific departments, the Board's advice would aid the Government of India in prosecuting practical research into those questions of economic or applied science, on the solution of which the progressive prosperity of the country, especially as regards its agricultural and industrial development, so largely depends.

The Board advises generally upon the operations of the departments, with due attention to the economic side of their work, and serves as a reference on all matters connected with the organization of scientific enquiry in India. It annually discusses the proposals of each departmental head in regard to the programme of investigation in his department; and in cases where inter-departmental co-operation is necessary, it advises as to the lines on which mutual assistance should be given and the department to which the enquiry should primarily appertain. It submits annually to the Government a general programme of research, embodying the proposals of departmental heads in so far as its subjects are to be exclusively dealt with in one department, and its own proposals in cases where two or more departments are to co-operate, and at the end of the year it presents a brief review of the results obtained during the year in all lines of scientific investigation controlled by its members. Its reports and programmes are communicated

through the Secretary of State to the Royal Society, who have appointed an Advisory Committee to consider them, and who from time to time furnish the Board and the Government of India with valuable suggestions and advice.

The present members of the Board of Scientific Advice are:

Name.	Appointment.
Mr. R. W. CARLYLE, C.I.E., I.C.S.	Secretary to the Government of India in the Department of Revenue and Agriculture. *Ex-officio* President.
Colonel F. B. LONGE, R.E.	Surveyor-General of India.
Dr. GILBERT T. WALKER, M.A., Sc.D., F.R.S.	Director-General of Observatories.
Sir T. H. HOLLAND, K.C.I.E., F.G.S., F.R.S., A.R.C.S.	Director, Geological Survey of India.
Captain A. T. GAGE, I.M.S., M.A., B.Sc., M.B., F.L.S.	Director, Botanical Survey of India.
Dr. N. ANNANDALE, B.A., D.Sc.	Superintendent, Natural History Section, Indian Museum.
Mr. F. BEADON-BRYANT.	Inspector-General of Forests.
Mr. J. W. MOLLISON, M.R.A.C.	Inspector-General of Agriculture.
Colonel H. T. PEASE, C.I.E., I.C.V.D.	Inspector-General, Civil Veterinary Department.
Mr. I. H. BURKILL, M.A., F.L.S.	Superintendent, Industrial Section, Indian Museum.
Colonel S. G. BURRARD, R.E., F.R.S.	Superintendent, Trigonometrical Surveys.
Dr. MORRIS W. TRAVERS, D.Sc., F.R.S.	Director, Indian Institute of Science.

List of Sub-Committees.

Sub-Committee A.—(*Meteorology, Terrestrial Magnetism and Cognate Subjects*).

1. The Surveyor-General of India (Chairman) ;
2. The Director-General of Observatories ;
3. The Director, Geological Survey of India.

Sub-Committee B.—(*Agricultural Products*).

1. The Director, Botanical Survey of India (Chairman) ;
2. The Superintendent, Industrial Section, Indian Museum ;
3. The Inspector-General of Agriculture.

Sub-Committee C.—(*Soils and Manures*).

1. The Inspector-General of Agriculture (Chairman) ;
2. The Director, Geological Survey of India ;
3. The Inspector-General of Forests.

Sub-Committee D. (*Forest Products*).

1. The Inspector-General of Forests (Chairman) ;
2. The Superintendent, Industrial Section, Indian Museum ;
3. The Director, Botanical Survey of India.

Sub-Committee E.—(*Veterinary subjects*).

1. The Inspector-General, Civil Veterinary Department (Chairman) ;
2. The Inspector-General of Agriculture ;
3. The Superintendent, Natural History Section, Indian Museum.

Sub-Committee F.—(*Libraries*) :

1. The Director, Geological Survey of India (Chairman) ;
2. The Director-General of Observatories ;
3. The Superintendent, Industrial Section, Indian Museum ;
4. Colonel S. G. Burrard, R.E., F.R.S. ;
5. Morris W. Travers, Esq., D.Sc. F.R.S.

CONTENTS.

ANNUAL REPORT

OF THE

BOARD OF SCIENTIFIC ADVICE FOR INDIA

FOR

1907-08.

SUMMARY OF PROCEEDINGS.

Twelfth Meeting held at Calcutta on the 14th February 1908.

CORRESPONDENCE between the Secretary of State for India and the Government of India with reference to the postponement of a general revision of the Dictionary of Economic Products, and between the Director of the Geological Survey and Mr. D. W. Freshfield on the progress of the Survey of Himalayan Glaciers was read and recorded.

The Board considered the Report of Sub-Committee B, on the preparation of a Manual of Indian Cultivated Plants, wherein the scope of such a manual and the agency by which it should be compiled were discussed, and resolved to adopt the Report and forward it to the Government of India.

The Report of the same Sub-Committee in which were discussed at considerable length proposals for the reorganisation of the Botanical Survey of India, and the Report of a special Sub-Committee on the future organisation of the Department of Economic Products, were considered by the Board, which resolved to adopt both reports and forward them with strong recommendations to the Government of India.

The Board had under consideration the remarks of the Advisory Committee of the Royal Society on the Report of the Board for 1905-06

and its Programme for 1907-08. The subjects discussed included the submission of the Board's Programmes for the consideration of the Advisory Committee; the preparation of a Hand list of the species of the Flora of India; agricultural subjects generally and in particular Economic and Industrial Chemistry and the limits of the Imperial Mycologist's research work; proposals for an increase of staff of the Zoological section of the Indian Museum, and the relation of the Museum to other departments engaged in Zoological research; anthropological work in India; the collecting of properly named wood specimens by the Forest Department; the work of the Civil Veterinary Department; the organisation of the work and staff of the Geological Survey, and proposals for a special report on the progress of that Survey.

The conclusions arrived at by the Board in these several matters were that as regards the preparation of a Hand list of the Flora of India, although its importance was recognised, lack of staff and presence of more immediately necessary work precluded its preparation forthwith; that as regards Agricultural subjects generally, Economic and Industrial Chemistry and the work of the Imperial Mycologist in particular, expression of opinion should await the results of the discussion of those subjects by the Board of Agriculture for India; that as regards Zoological subjects, reference should be made as far as possible to the Zoological Section of the Indian Museum by other departments; that as regards the increase of staff the Board understood that proposals had already been forwarded by the Government of India to the Secretary of State; that as regards anthropological work, it did not come within the province of the Board as at present constituted; that as regards the collection of wood specimens the attention of the Inspector-General of Forests should be drawn to the subject; that as regards Veterinary subjects both the remarks of the Advisory Committee of the Royal Society and the note of the Inspector-General of the Civil Veterinary Department on previous remarks should be referred to Sub-Committee E for report at the next meeting of the Board.

With regard to the Geological Survey the Board were of opinion that no undue proportion of time or of officers was taken up in answering economic enquiries as such enquiries were dealt with only by officers at headquarters. The Board agreed with the Director of the Geological Survey in thinking that a further immediate expansion of the Department was inadvisable and that there was no officer available for the

increase of work that the preparation of a special report on the progress of the survey would necessitate.

After consideration of a letter from the Superintendent of the Natural History Section of the Indian Museum the Board resolved that it should be stated in the Annual Report of the Board that the teaching of Medical Zoology being without the province of the Board was not considered in its Annual Report.

The other items discussed were formal.

Thirteenth Meeting held at Simla on the 11th May 1908.

An endorsement from the Government of India forwarding a letter from the Director of the Botanical Survey on the preparation of a Manual of Indian Cultivated Plants and a Hand list of the Indian Flora and another endorsement forwarding correspondence from the Royal Society of London on various meteorological subjects were read and recorded.

The Report of Sub-Committee E on the work of the Civil Veterinary Department with reference to the remarks of the Royal Society's Advisory Committee was considered. The Board resolved to endorse the report of Sub-Committee E and to forward it to Government with an expression of opinion that the staff of the Civil Veterinary Department was being utilised to its full extent and was working on right lines. A letter on the same subject from the Inspector-General of the Civil Veterinary Department forwarded by Government was referred to the same Sub-Committee for report at the next meeting of the Board.

The Programmes for 1908-09 of the various Scientific Departments except that of the Geological Survey were discussed. The Board resolved that in view of the overlapping of certain subjects the combined programmes of the Director of the Imperial Institute and the Reporter on Economic Products and the programme of the Forest Department should be revised under the guidance of Sub-Committee D; also that it was unnecessary to include in the programme of the Imperial Institute the investigation into Indian Turpentine and oil-seeds and into the rubbers of *Ficus elastica* and *Ceara* so far as it referred to work for India, as the Forest Department was also conducting researches into Turpentine and oil-seeds and was endeavouring to dispose of its rubber plantations.

A letter from the Director-General of Observatories forwarded under Government endorsement embodying a report on the recommendations

of the Advisory Committee of the Royal Society on certain items in the programme of meteorological research in India was read. The Board resolved to accept the modifications in the programme of the Meteorological Department proposed in the above letter.

Correspondence between the Government of India and the Director of the Geological Survey forwarded under Government endorsement concerning the suggestions of the Royal Society's Advisory Committee as to the expansion of the Geological Survey Department and other subjects connected therewith was read and recorded. The correspondence was practically to the same effect as the resolution of the Board on the same subjects passed at the former meeting of the Board and referred to in the preceding summary.

A letter from Dr. M. W. Travers on the proposed removal of the Civil Engineering College from Sibpur to Ranchi was read and recorded.

Fourteenth Meeting held at Calcutta on the 22nd December 1908.

The Board considered a letter from the Government of India in which the opinion of the Board was requested as to the possibility of arranging future programmes so as to distinguish between continuance of investigations already in progress and entirely new lines of work. The Board agreed that as far as possible this should be done, but were of opinion that it could not necessarily undertake to give an account in the programme of the stage at which any particular investigation had arrived as this would involve practically the preparation of a subsidiary report.

Correspondence with the Royal Society on meteorological subject was read and recorded.

A despatch from the Government of India to the Secretary of State forwarded under Government endorsement reporting on the action taken on the previous recommendations of the Royal Society's Advisory Committee on various subjects was read and recorded.

Correspondence regarding the collection of properly identified wood specimens in which was embodied a circular issued by the Inspector-General of Forests on the subject, and correspondence regarding the addition of sections to the Annual Report of the Board were read and recorded.

The Draft Annual Report of the Board for 1907-08 was then discussed and the Board resolved to adopt the report with modifications

in some of the sections. The report on work done at the Imperial Institute arrived in India too late for consideration by the Board assembled and it was resolved to circulate copies to members of the Board for consideration.

The report of Sub-Committee D on the overlapping of programmes of the Forest Department and of the Reporter on Economic Products and the report of Sub-Committee E on the work of the Civil Veterinary Department were read and accepted by the Board.

Copy of a Despatch from the Government of India to the Secretary of State forwarded under Government endorsement reporting on the action taken on the recommendation of the Advisory Committee by the Royal Society relating to Veterinary subjects was read and recorded.

ANNUAL REPORT FOR 1907-08.

INDUSTRIAL AND AGRICULTURAL CHEMISTRY.

BY

J. W. LEATHER, PH.D., F.I.C., F.C.S.,
Imperial Agricultural Chemist;

AND

D. HOOPER, F.C.S., F.I.C.,
Curator (Industrial Section), Indian Museum.

Oils and Oil-Seeds.—In the Indian Museum some attention has been given to the investigation of the lesser known oil-seeds of India and the properties of the fixed oils extracted from them. Many oils are used in the country but not exported, and their examination has been considered necessary to complete a chemical survey and indicate the uses to which they may be put. The first group examined was the Terminalias or Myrobalans.

Terminalia Catappa.—Country Almond. The kernels of the seeds yielded 48·3 per cent. of a non-drying oil. Specific gravity at 15°C, 0·9206; acid value, 7·77; saponification value, 205·04; iodine value, 81·8; fatty acids, per cent., 95·2; titer test, 42.

Terminalia Belerica.—Nuts from the Central Provinces are stated to yield 25 per cent. of Baheda oil, which is odourless and tasteless, clear, and yellow in colour. Two samples had the following characters: specific gravity, 0·9168 and 0·9193; acid value, 2·48 and 3·97; saponification value, 205·8 and 205·3; iodine value, 79·04 and 85·38; Reichert-Meissl value, 0·76 and 0·78; fatty acids per cent., 94·2 and 93·6; titer test, 39° and 38°.

Terminalia Chebula.—Chebulic myrobalans gave only a small proportion of kernels which yielded 36·71 per cent. of yellowish, semi-drying oil. Acid value 8·91; saponification value, 192·66; iodine value, 87·5; fatty acid, 96·2 per cent.

Cucurbitaceous seeds. Cucurbita Pepo.—The seeds of the pumpkin or vegetable marrow, yield to solvents about 25 per cent. of fixed oil. Two samples had the following characters: specific gravity, 0·926 and 0·928; acid value, 12·78 and 10·86; saponification value, 195·7 and 196·2; iodine value, 126·0 and 129·6; Reichert-Meissl value, 0·43 and 0·52; fatty acids, 94·9 and 94·7 per cent.; titer test, 31° and 32°.

Cucurbita maxima or squash gourd seeds yield oil with the following characters: specific gravity, 0·919 to 0·926; acid value, 6·38 to 17·65; saponification value, 194·9 to 197·1; iodine value, 88·7 to 133·4; Reichert-Meissl value, 0·47 to 0·67; fatty acids per cent., 94·3 to 95·8; titer test, 32° to 38°.

Cucumis sativa or cucumber seeds gave a pale yellow slowly drying oil. Two specimens had the following characters: specific gravity, 0·924 and 0·923; acid value, 11·49 and 10·68; saponification value, 195·6 and 196·9; iodine value, 117·6 and 118·5; Reichert-Meissl value, 0·52 and 0·52; fatty acids, 94·2 and 94·6; titer test, 35·5°.

Luffa ægyptiaca seeds gave a dark greenish oil with a high acid value, slowly drying. Specific gravity, 0·921 to 0·926; acid value, 33·0 to 36·4; saponification value, 193·0 to 195·8; Reichert-Meissl value, 0·49 to 0·52; fatty acids, 93·5 to 94·2; titer test, 34° to 35°.

Citrullus Colocynthis.—Colocynth seeds from Baluchistan gave 17·8 per cent. of drying oil: acid value, 5·94; saponification value, 202·9; iodine value, 129·3; fatty acids 92·2; titer value, 29°C.

Mesua ferrea.—The iron wood tree, Nagkesur or Nahor of Assam bears seeds yielding 41·6 per cent. of fixed oil, the kernels alone giving 72·9 per cent. It is deep yellow or brown, bitter to the taste, and deposits a white crystalline fat at ordinary temperatures. Specific gravity, 0·9166 to 0·9359; m. pt., 16·5° to 26·7°; acid value, 38·4 to 115·0; saponification value, 203·7 to 205·8; iodine value, 87·0 to 89·1; Reichert-Meissl value, 7·7 to 11·5; fatty acids, 92·2 to 94·1 per cent.; titer test, 33·5 to 35·5. The solid fatty acids consist mainly of stearic acid.

Sterculia fœtida.—Java almonds yield 34 per cent. of bland, light yellow, non-drying oil; specific gravity, 0·919 at 30·5°; acid value, 6·5; saponification value, 199·3; iodine value, 83·0; fatty acids, 95·6 per cent.; titer value, 31·5.

Chrozophora verbascifolia, or Tannoom seeds, yield about 35 per cent. of an oil said to be used by the Bedouins of Arabia instead of ghee. The oil is thick, yellowish and drying. Acid value, 3·3; saponification value, 200·2; iodine value, 137·0; titer value, 30·5°.

Lawsonia alba.—The Mehndi or Henna plant. The seeds afford a very small quantity of fixed oil—10·5 per cent.—to volatile solvents. This is of a green colour and possesses drying properties.

Himalayan Black Bear (*Ursus torquatus*).—The fat of this animal is supposed to have curative properties and is sold in Northern India. It consists of olein, palmitin and stearin in nearly the same proportions as pig's lard.

Tamarindus indica.—The seeds deprived of their brown covering afford a nutritious and palatable food. They are not oil-seeds. The Agricultural Ledger No. 2 of 1907 furnishes full information on the uses of these seeds in times of scarcity, and gives the composition of the seeds and kernel.

Dyes—Indigo.—The correct determination of indigotin in commercial indigos, and of indican in the fresh leaf of the plant, has been the subject of two more communications from Messrs. Bergtheil and Briggs and from Messrs. Gaunt, Thomas and Bloxam, respectively (*Journal of the Society of Chemical Industry*, Vol. XXVI, 1907, pp. 1172-1185), but these are chiefly concerned with notice of improved details of their processes or with criticisms. The "isatin" method of determining indican in the leaf is said by Mr. Bloxam and his colleagues to yield considerably higher results than the "persulphate" method recommended by Mr. Bergtheil, and the former therefore conclude that the potentiality of the dye yield of the plant is greater than has been supposed. Mr. Bergtheil on the other hand found in his laboratory that the persulphate method yields, if anything, the higher value. Mr. Bloxam and his colleagues quote certain determinations of the proportion of leaf on the plant, which indicate *circa* 62 per cent., whereas Mr. Bergtheil, as the result of other determinations, considers 40 per cent. to be the average figure.

Datisca cannabina.—Korezynski and Marchlewski have continued their investigations of the dye stuffs from the roots of this plant. The glucoside from which datiscetin is derived has the composition $C_{21}H_{22}O_{13}$. On hydrolysis it yields 56 per cent. of datiscetin and 33 per cent. of dextrose. A new compound, tetraben-zenesulphoyl-datiscetin, has been separated in white crystals, melting at 188°C.

Morinda citrifolia.—The wood and root-bark of this well known Indian dye stuff have been re-examined by Drs. Oesterle and Tisza of Berne. From the root-bark the following substances were separated and analysed. (1) Morindin, $C_{27}H_{30}O_{15}$ melting at 210°; (2) Trioxy methylanthrachinon monomethyl ether, $C_{16}H_2O_5$, melting at 172°; (3) Morindadiol $C_{15}H_{10}O_4$, melting at 244°; (4) Soranjidiol, $C_{15}H_{10}O_4$ melting at 276°; and a wax $C_{18}H_{28}O$ melting at 124·5°.

Nyctanthes arbor-tristis.—E. G. Hill and A. P. Sirkar, of Allahabad, have separated a red crystalline colouring matter and mannitol from the flowers of this tree. The colouring matter was found to have the formula $C_{20}H_{27}O_4$, and appeared to be acid in character,

and to contain one hydroxyl group and one or more methyl groups. The name nyctanthin is suggested for it.

Drugs.—Garcinia pedunculata.—The sliced and dried fruits are used as a mordant in dying, as an adjunct in food, as a refrigerant drink or sherbet. The drug is called "Heibung" in Manipur and "Metlin" in Burma, and belongs to a class of acid vegetables used in the East to which the name "Amsul" is applied. Three samples in the Indian Museum contained respectively 13·29, 18·04 and 19·7 per cent. of malic acid. The dried fruits retain their acid property for several years without deteriorating.

Amphicome Emodi.—The root and stem of this plant are known in Jammu and Kashmir as "Kaur" or bitter, and are prescribed for fever. The drug was found to contain an alkaloid, an acid fat, a wax, yellow colouring matter and sugar. The alkaloid is intensely bitter and is probably the active medicinal agent of the plant.

Alcoholic Liquors and other Exciseable Articles.—The reports from the Central Excise Laboratory for India, Kasauli, under the control of Major C. H. Bedford, I.M.S., deal as usual with the solution of many problems connected with the manufacture of and trade in alcoholic liquors and other articles subject to Excise and Customs duties. The special enquiries for the Government of India included a complete revision of Sikes's Tables which are used by the Excise and Customs for estimation of spirit strengths. At the high temperatures usually prevailing in India and with the low strength spirits issued, the under-estimation of alcoholic strength by the use of the old tables was considerable. New tables for the accurate reduction and blending of spirits were also published and will allow of most efficient and rapid work being effected in these processes.

The amount of obscuration of the alcoholic strength arising from various causes was investigated. The obscuration due to casking spirits for various periods, to the practice of compounding spirits with colouring and flavouring agents, and to the addition of caramel and sugar solutions, formed the subject of numerous experiments upon which reports were furnished to Government. Other enquiries embraced the subject of standards for Beers in India, allowances for spirit wastages during transit in India, the alcoholic strength of toddy (tari) at different stages after being drawn from the palm-trees, new methods for denaturation of spirit in India, and the average spirit-yielding capacity of mahua, gur and other fermentative bases.

Enquiries for Local Governments include such matters as the standardisation of excise hydrometers, thermometers and saccharometers; analyses of factitious and of imported and Indian distillery spirits; of samples of Indian hemp, opium and cocaine; reports on disposal of Distillery-effluents, and on certain cases in which explosions in distilleries have occurred; estimation of the amount of copper-salts in spirits; the fermentative activity of Chinese yeasts in Burma; causes of defective yields during spirit manufacture, etc.

Major Bedford was on duty in Burma for six weeks during 1907 to investigate certain Excise problems, and a "Report on the Manufacture, Quality, etc., of Alcoholic Liquors in Burma" was furnished to that Government. "A technical Excise Manual" embodying the results of the special enquiries made at the Central Excise Laboratory is being prepared for publication.

Solubility of Calcium Carbonate in natural waters.—In relation to some work which is in progress at the Agricultural Research Institute, Pusa, on the concentration of certain soil constituents in the water of the soil, a correct knowledge of the relation which holds between calcium carbonate, carbonic acid and water when exposed to an atmosphere containing carbon dioxide gas was necessary. Apart from odd determinations of the amount of calcium carbonate dissolved, previous work on this subject is limited to that of Schloessing [*Comp. rend.* 74 (1872) 1552] and of Treadwell and Reuter [*Zeits. f. anorg. chem.* 17 (1898) 170]; in both cases the investigation was limited to one temperature (16°C. and 15°C, respectively) and the results obtained were in themselves divergent. The system has accordingly been subjected to a careful quantitative examination at temperatures varying from 15° to 40°C., and with partial pressures varying between ·5 and 35 per cent. CO_2. A general formula has been deduced and the data are about to be presented for publication as a Memoir.

Bibliography.

BERGTHEIL, C., AND BRIGGS, R. V.—The determination of indigotin in indigo-yielding plants. [Journ. Soc. Chem. Ind. xxvi (1907) 1172.]

GAUNT, E. THOMAS, F., AND BLOXAM, W. P.—Analysis of indigo (Part iii) and of the dried leaves of Indigofera arrecta and Indigofera sumatrana. [Journ. Soc. Chem. Ind., xxvi (1907) 1174.]

HERRIMANN, FRANZ—Rottleiz (Archiv der Pharmazie 245, 572-585).

HILL, E. G., AND A. P. SIRKAR.—A new colouring matter from Nyctanthes arbor-tristis. (Journ. Chem. Soc., XCI, 1501.)

HOOPER, D. . . Sunflower seed and oil (Agricl. Ledger No. 1 of 1907.)

HOOPER, D. . . Tamarind seed (Agricl. Ledger, No. 2 of 1907).

HOOPER, D. . . Nutmeg fats (Agricl. Ledger, No. 3 of 1907).

HOOPER, D. . . Mexican Poppy (Agricl. Ledger, No. 5 of 1907).

HOOPER, D. . . Himalayan Bear's fat (Journ. Asiatic Soc. of Bengal, 1908, p. 33).

HOOPER, D. . . Oil of Lawsonia alba (Journ. Asiatic Soc. of Bengal, ib., p. 35).

HOOPER, D. . . Amphicome emodi (Pharm. Journ. 79, p. 506).

KOREZYNSKI, A., AND L. MARCHLEWSKI.—Datisca cannabina (Anz. Akad. Wiss. Krakau, 1907, 124).

LEATHER, J. W. . The loss of water from soil during dry weather, (Memoir of the Dept. of Agricl. in India, Chemical Series, No. 6).

OESTERLE, O. A., AND E. TISZA.—Morinda citrifolia (Archiv der Pharmazie, 245, 287-290 and 246, 150-164).

FOREST CHEMISTRY.

BY

PURAN SINGH, F.C.S.,

Acting Imperial Forest Chemist.

The office of the Imperial Forest Chemist was opened in July 1907 and the investigations commenced during the year from June 1907 to July 1908 are detailed below together with a summary of the progress made.

A chemical investigation of several samples of cutch was made, and the existing method of detecting adulterants in cutch by estimating its alcoholic extract has been supplemented by one more direct, namely, the estimation of a methyl alcohol extract. Although the presence of catechin, which itself is a dyeing agent, makes up to a greater or lesser extent for the deficiency of catechu tannin in poorer samples of cutch, yet in a cutch which is fairly rich in catechu tannin, the presence of much catechin is distinctly detrimental to the quality of cutch as a dyeing agent. It has therefore been recommended that as much catechin as possible should be extracted from cutch, for in this way not only is the quality of the latter improved but *katha* which consists essentially of catechin is obtained as a "bye-product."

Investigation into the causes which lower the value of cutch as a dyeing agent and the possibility of improving its quality.

The method hitherto adopted for isolating catechin from cutch has been to crystallise the former out from a solution of the latter in hot water. In this method a considerable quantity of valuable catechin is decomposed into the less valuable tannin. To avoid this loss a scientific method of isolating catechin from catechu-tannic acid has been suggested in substitution of the very crude customary method referred to above. Further as a result of a protracted chemical investigation, some new properties of the chief constituents of cutch, catechin and catechu-tannic acid have been discovered by the aid of which it has been possible to propose more accurate and speedy methods of cutch analysis, employing methyl alcohol or wood spirit instead of water to effect the separation of catechin and catechu-tannic acid from cutch, and substituting for acetic ether a mixture of ether and carbon disulphide (termed "catechin mixture" by the writer), for the accurate estimation of catechin and catechu tannin. Finally owing to the prospective distillation of wood spirit on a large scale in India, the possibility has been indicated of applying these improved methods to the refining of cutch and to the commercial manufacture of good *katha* and even chemically pure catechin.

Two logs of *Acacia catechu* growing in the Goalpara Division of Assam, near the Aie river, which were submitted to the Institute for analysis and report have been subjected to a complete chemical examination with very promising results. The general belief that *Acacia catechu* growing in moist localities contains no catechin has been shown to be without foundation, for one of the samples of the wood yielded on

The possibility of extracting on a commercial basis *Katha* or Cutch or both from Acacia Catechu growing in moist climates.

analysis about three per cent. of catechin and the other gave about five per cent. of the same. Further, though the Katha-boilers of Kumaon and Burma declared such wood to be unsuitable both for *katha* and cutch making, the chemical analysis permitted the conclusion that the wood is suitable for the manufacture both of *katha* and cutch. This conclusion (at least as regards the extraction of cutch) has been confirmed by the results of experimental manufacture of cutch from the Goalpara wood. Further, the quality of the cutches so manufactured has been experimentally investigated and the laboratory results have been substantiated by actual trials of these, that is by performing dyeing experiments with them on a large scale.

The native system of rejecting certain wood of *Acacia catechu* as useless for *katha* and cutch-making has been shown to be unsatisfactory and a simple scientific process by which a preliminary assay of the wood can be easily effected has been proposed to ascertain whether or not a tree is suitable for *katha* manufacture.

An interesting point has been brought out in connection with this investigation, namely, that catechin as occurring in the *Acacia catechu* growing in moist localities is amorphous, while in trees from other localities it exists as crystals. The crystalline variety of catechin is decomposed in contact with boiling water, while the other variety rather assumes its crystalline form by contact with water.

As a result of this investigation, the Assam khair forests appear well adapted for the manufacture of *katha* and cutch, and suggestions have been made for improving the quality of these products from these forests.

The possibility of refining seedlac into shellac with greater economy and ease than is possible in the existing method, *viz.*, trituration of seedlac with water.

Before raw seedlac is manufactured into shellac, it has to be refined at present by triturating or washing it with water. This process of trituration, it is well known, is extremely tedious and wasteful, and besides, involves a large amount of labour. Again during the process of melting the washed lac to turn it into shellac there is a further loss in the quantity of this important resin in the form of *gand*. A more economic and convenient method has been proposed of refining all forms of raw seedlac by means of wood spirit, and an apparatus (a modification of the extracting apparatus of Dr. Wilhelm Nag Ngai of Tokyo) has been designed, by means of which the whole of the pure lac resin can be easily extracted from raw lac. The results

obtained in the Laboratory by refining crude lac with wood spirit have no doubt been promising, but, in order to confirm these, further experiments require to be made with large quantities of crude lac. For this purpose a capacious model of the apparatus referred to above is to be constructed. It is not, however, claimed that the proposed method can supersede the existing method with advantage, until wood distillation is started in India on a commercial scale.

Utilization of "Coagulated" seedlac.

Two samples of lac (one called Phunki and the other Coagulated or "clogged-up"), received from the Central Provinces have been submitted to chemical examination. It has been shown that the varieties, though widely different in physical appearance, furnish nearly equal amounts of pure lac resin, and thus the popular belief that in coagulated lac most of the pure resin is decomposed and irrecoverably lost is groundless, and consequently the lac dealers' practice of rejecting it as useless for shellac-making is not justified. It has further been shown that the defects in the appearance of the coagulated lac are due to purely physical causes, and that they are remediable.

The possibility of preparing shellac of a uniform quality and character from all the different qualities of raw seedlac.

Some experiments on the extraction of pure lac resin from various forms of crude seedlac have been made on a small scale, but it has not yet been possible to determine the relative value of the different refined extracts owing to the insufficiency of material available for investigation. The subject will be taken up, when the proposed apparatus referred to above which is under construction is received.

Extraction of Ngai Camphor from *Blumea balsamifera* D. C.

Fresh green samples of *Blumea balsamifera* were analysed in Burma, and the total volatile matter (consisting chiefly of camphor and oil) in their etherial extracts was determined at Toungoo and Mawhan. A large quantity of *Blumea balsamifera* leafy branches was baled and sent to Dehra Dun from Mawhan.

The air dried samples were again analysed at Dehra Dun both by other extraction and by steam distillation. From these different laboratory experiments, the total percentage of camphor and volatile oil present in the wood was determined. During the distillation of the wood with steam, crystals of camphor were noticed in the receiver. These crystals were separated and identified as those of l-borneol (Ngai camphor). The Chinese method of extracting camphor from the weed

was also tried successfully, but the camphor thus prepared was not very pure.

All the experiments show the possibility of the *Blumea balsamifera* of Burma becoming an important commercial source of Ngai camphor. Experiments on a commercial scale, however, have yet to be made with the experimental camphor-still designed by the Forest Chemist for the purpose. The still being under construction, a final report on the subject will be made later on.

Burmese varnish (the sap of *Melanorrhœa usitata*) and its constituents.

The sap of *Melanorrhœa usitata*, which has never been chemically examined before, has been subjected to a complete chemical examination, and it has been shown that it furnishes the same constituents as the well-known Japanese lacquer, which is the sap of *Rhus vernicifera*. The commercial varnish of Burma is a slow drying varnish as compared with that of Japan. The Burmese are known to adulterate their varnish with sesamum oil. Chemical investigation has shown this practice to be detrimental to the drying capacity of the varnish. As a result of this investigation, suggestions have been made for improving the quality of the Burmese varnish and the lacquering industry in Burma.

Indian Turpentine.

An interesting series of experiments started some time back by Mr. P. H. Clutterbuck, Deputy Conservator of Forests, Naini Tal, with the object of improving the quality of turpentine distilled at present at the Bhowali Government Turpentine Distillery, has been completed during the year. Fractional distillation of various samples of Indian turpentine prepared under different conditions were made by the Imperial Forest Chemist. At present the turpentine oil distilled from *Pinus longifolia* at Bhowali contains only about 50 per cent. of low boiling terpenes. By repeated experiments in conjunction with Mr. Clutterbuck, it has been finally settled that by redistilling a certain fraction of oil and mixing it up with the other fractions, a good oil with 90 per cent. of low boiling terpenes can be obtained. A joint report on the subject by Mr. P. H. Clutterbuck and the writer is under preparation.

Podophyllum Emodi and the soils in which it grows.

An enquiry into the relative differences in amounts of resin contained in the *Podophyllum Emodi* growing in different localities in Jaunsar and Hazara has been completed, together with the analysis of the soils from which the different samples of Podophyllum analysed were collected. The Hazara samples were found to be much richer in resin

than those collected in Jaunsar. The Hazara soils contain a greater percentage of humus and organic matter than the Jaunsar soils.

List of Publications.

PURAN SINGH . . A Note on Cutch Analysis and the preparation of Pure Catechin.

PURAN SINGH . . A Note on the Utilization of Khair Forests in Eastern Bengal and Assam.

PURAN SINGH . . A Paper on the Future of Cutch and Katha Manufacture (read at the Provincial Forest Conference held at Lahore in January last).

ASTRONOMY.

BY

GILBERT T. WALKER, M.A., Sc.D., F.R.S.,
Director-General of Observatories.

Solar Physics.—Researches in solar physics are carried on under the direct control of the Government of India at Kodaikanal, the Director being Mr. Michie Smith and the Assistant Director Mr. J. Evershed. Mr. Michie Smith was on leave from the 1st April 1907 to the 2nd January 1908. The chief instruments are:—

(*a*) A spectroheliograph made by the Cambridge Scientific Instrument Company, the object of which is that of making photographs of the sun using the light emitted by one chemical element only. In this apparatus a stationary image of the sun is made by a 12-inch triple-achromatic lens of 20-foot focus, fed by an 18-inch Foucault siderostat. Close up to the image and somewhat longer than its diameter is the narrow vertical slit of a spectroscope arranged in such a manner that the light which has passed horizontally through the collimating lens shall be deflected through two right angles by two prisms and a mirror, and shall so emerge from the camera lens parallel to its original direction. This light then falls upon another vertical slit which can be adjusted in such a position as to allow light of any desired wave length to pass through. In the Kodaikanal spectroheliograph the collimating and camera lenses, each of 5-inch aperture and 6-foot focal length, together with the

prisms and slits, are attached to a rigid framework, while immediately in contact with the slit last described is a stationary photographic plate within a fixed camera. The rigid framework is capable of motion in a horizontal plane in such a manner that the primary slit may pass uniformly across the image of the sun while the secondary slit will move at an equal rate across the sensitised plate; and as in each position an image will be formed at the second slit by light of the desired wave length and no other light can emerge, the result of the movement upon the plate is a complete image of the sun in monochromatic light. At present the H and K lines of calcium are largely used on account of the convenience afforded by the width of their absorption shading and the fact that the centre of the dark line is frequently 'reversed', *i.e.*, is bright instead of dark, indicating that the calcium vapour is abnormally hot in the higher levels of the solar envelope. A photograph so obtained shows bright clouds—called 'flocculi'—of calcium vapour scattered about over the sun and gives a large amount of information that is not otherwise obtainable. Further, by causing the slits to move more slowly the exposure may be lengthened sufficiently to give photographs of the 'prominences' projecting from the sun's margin.

(*b*) Two 6-inch refractors, with one of which an Evershed spectroscope has been used since November 1904. These are used for visual examination of the sun and for spectroscopic study of spots and prominences.

(*c*) A spectrograph consisting of an 11-inch polar siderostat with a 6-inch Grubb lens of 40-foot focus. This is used with a 4-inch concave grating of 10-foot focus mounted on Rowland's plan, or a parabolic grating collimated to cure astigmatism, or a plane grating with collimator and camera lenses of 8-foot focus. A powerful spectrograph has also been erected in the spectroheliograph room, using a 3-inch plane grating. It is employed in photographing the ultra-violet region in spot spectra and in studies on the line of sight movement of the chromospheric gases. Both spectrographs have been fitted with special occulting shutters for regulating exposures in spot spectrum work.

(*d*) A photoheliograph by Dallmeyer. With this a photograph of the sun in ordinary light is made daily when possible. Originals are

sent to Greenwich for the use of the Solar Physics Committee for those days for which photographs are not available from Greenwich or Dehra Dun.

2. In addition to the use of the spectroheliograph and photoheliograph the routine work includes visual examination of sunspots and faculæ, observations of widened and displaced lines in sunspot spectra and spectroscopic observations of prominences. A monthly article describing the solar activity is contributed to the "Monthly Weather Review," while for more technical purposes bulletins of the observatory are issued. Of these thirteen have appeared, the last including the prominences observed up to the 31st December 1907.

3. A new spectroheliograph has been designed and partly constructed at the observatory for photographing the sun's disc in the hydrogen radiations. Recent work in this direction by Professor Hale has shown the importance of securing records in the hydrogen radiation H_a. It is hoped that daily photographs in H_a will be taken with the new spectroheliograph when a grating and a suitable collimating lens have been obtained.

4. Photographs of spot spectra are now made in which different exposures are given for the spot and for the adjacent photosphere so that equally dense images of both spectra may be obtained: these are then copied and enlarged with a special apparatus so as to bring out clearly the characteristic features of the spot spectrum. The parabolic grating spectroscope has been remounted in a more convenient form and a number of excellent photographs obtained with it. Arrangements have also been made by which the slit of this spectroscope can be replaced by negative lens and enlarged images of sunspots obtained on a scale of about one metre to the sun's diameter.

5. A series of spot spectra taken during the year with the parabolic grating spectrograph give an excellent record of the spectrum between D and F, and the measurements are now completed of about 1,000 lines specially affected in the spot as compared with the photosphere spectrum. Measurements of the displacements of certain iron lines most affected by pressure have been made and these indicate that no difference of pressure exceeding a quarter of an atmosphere can exist between the absorbing gases of spots and those of the photosphere. The result has an important bearing on the vexed question of the level of sunspots, since in the spots photographed there is probably no difference of level between the absorbing layer in the spots and the absorbing layer of the photosphere.

6. Provisional values of the wave length of the hydrogen lines δ and ε have been determined from photographs of the spectrum of the sun's east and west limbs using the 3-inch grating spectrograph. The results which are accurate to 0.01A show conclusively the very close accordance of the values of these lines with the theoretical values derived from Balmer's formula, and differ from the measures of the lines made by Rowland in the ordinary solar spectrum. In the course of this work on the hydrogen lines an interesting fact was brought to light, namely, the higher rotational speed of the gases of the upper chromosphere as compared with the low-lying metallic vapours. This feature has since been discovered independently by Hale and Adams.

7. The 3-inch grating spectrograph has now been modified so as to photograph the east and west limbs simultaneously and under very high dispersion. A considerable number of measureable plates were secured during the fine weather and the research into the movements of the higher gases of the chromosphere is being continued.

8. Large scale photographs of selected regions of the sun's surface are now taken with the 12-inch photovisual lens using a positive enlarging lens and a special absorbing screen for limiting the light used to the region F to G, this region having a uniform focus with the 12-inch lens whilst beyond G the focus lengthens and at K is 8 mm. beyond the visual focus. Some very promising plates have recently been secured showing minute details in spot structure, etc.

9. In view of the importance of a knowledge of the variations in the solar radiation a scheme of observation has been devised which will be independent of all the methods at present in use and free from some of the uncertainties attending them. Variations in the amount of light given out by the sun will cause corresponding variations in the light of the full moon and a comparison of the latter with the light of certain stars whose light is known to be approximately constant should enable the variations in the light emitted by the sun to be determined. In view of the accuracy with which the relative densities of photographic images may be determined with a suitable photometer, changes of not less than 1 per cent. should be capable of determination in this manner. With this end in view apparatus has been prepared for obtaining out of focus images of bright stars on the same plate with similar images of the full moon. In order to reduce the moon's light to an amount comparable with that of a star and to employ the full aperture of the lens for both stars and moon, the latter is reflected at a known angle from a convex quartz

plate. In this way the intensity can be reduced any desired amount and the out-of-focus image formed from the integrated light of the whole disc of the moon becomes a circular disc of uniform density similar in all respects to that produced by the star. The relative densities can then be easily measured. The moon and stars are photographed at altitudes of not less than 60° and for each plate as nearly as possible at the same altitudes.

The only sources of uncertainty to which this method seems subject are want of uniformity in the transparency of the sky near the zenith and possible small variations in the magnitudes of the stars chosen for comparison. A series of photographs taken during each lunation before and after full moon during good atmospheric conditions should eliminate the former uncertainty, whilst errors arising from the latter could be neutralised by taking a sufficient number of comparison stars.

10. The observatory is now co-operating with the "International Union for Solar Research."

11. There is also at Poona, under the Government of Bombay, the Takhtasingji Observatory, where research in solar physics is carried on by Mr. Naegamvala. The chief portions of the equipment are:

(*a*) A Foucault siderostat with an 8-inch image lens for use with a spectroscope which is now being improved in England.

(*b*) An equatorial refractor with a Cooke 6-inch triple photovisual lens. This is provided with two 45° objective prisms, and a prominence spectroscope with a Thorpe transmission grating has been constructed locally for attachment to it.

(*c*) An equatorial reflector with a 20-inch mirror by Common. A focal-plane ultra-violet spectrograph is now in complete adjustment and it is proposed to employ it for stellar spectra.

The twelve 'most widened' lines in sunspot spectra are observed daily and the results forwarded to Sir Norman Lockyer, and a close agreement is maintained with the observations made at South Kensington. The observatory is also co-operating with the International Union for Solar Research, and is observing the region 5,300 to 5,500 for all lines affected in sunspots.

Solar Radiation.—Of the three Angstrom pyrheliometers previously in use in Simla one was taken in January 1908 to the Solar Physics Observatory at Kodaikanal for employment there. The operation of these instruments in Simla and Kodaikanal is difficult and intermittent on account of cloud and atmospheric dust and the results obtained are consequently

less valuable than the apparatus is capable of affording. The Royal Society have recommended that these and other solar instruments should be used at a very high altitude in the Himalayas, in a position free from atmospheric dust, but it is at present impossible for the department to make the necessary arrangements.

At Calcutta and Bombay there are Callendar electric sunshine recorders, and a third, which has been purchased for use in Simla, will shortly be brought into use.

The following list gives in absolute units the values of radiation as measured at Simla from April 1907 to August 1908 inclusive :—

Month.	Solar radiation in gr. calories per sq. cm. per min.			Number of observations.
	Maximum.	Minimum.	Mean.	
April 1907	1·55	1·47	1·51	2
May "	...	...	1·42	1
June "	1·39	1·22	1·33	8
July "	1·29	1·23	1·26	3
August "	...	...	...	...
September "	...	...	...	...
October "	1·49	1·48	1·49	3
November "	1·60	1·38	1·46	18
December "	1·53	1·34	1·43	15

Month.	Solar radiation in gr. calories per sq. cm. per min.			Number of observations.
	Maximum.	Minimum.	Mean.	
January 1908 . .	1·53	1·43	1·47	10
February „ . .	1·56	1·40	1·47	12
March „ . .	1·55	1·36	1·47	12
April „ . .	1·49	1·35	1·42	11
May „ . .	1·43	1·20	1·33	12
June „ . .	1·41	1·13	1·27	13
July „ . .	No observations on account of cloud.			
August „ . .				

METEOROLOGY.

BY

GILBERT T. WALKER, M.A., Sc.D., F.R.S.,

Director-General of Observatories.

Investigation of the Upper Air.—In view of the absence on leave of the head of the Department, work with kites could not be undertaken, but much was done to devise and improve methods of obtaining meteorological records of the air by means of balloons carrying light instruments.

2. As a first step for such work it was necessary to design recording instruments which should be light enough to be sent up to 60,000 feet without great expense in balloons and hydrogen, and cheap enough in themselves to justify the anticipated loss of 90 per cent. of them for the

sake of the 10 per cent. which it was expected to recover. As a result of experimental work an instrument was evolved which, while weighing complete only half an ounce, would inscribe on a silvered glass plate accurate records of pressure and air temperature up to a height of 60,000 feet or more, and of humidity throughout the lower half of that distance from the ground surface. Such a record in a light instrument is necessarily small, actually one centimetre square, and requires reading under a microscope with micrometer scales: also the film of silver is fragile, and as it would be damaged by the lightest touch of the fingers until it has been fixed by varnishing, it requires protection from meddling or inadvertent handling by the finder. To effect this protection the impact of the instrument with the ground after descent has been made to release the record plate and its holder, and to allow it to spring away into a narrow dark space in the framework of the instrument; when the record is thus concealed only a critical examination by an unusally inquisitive person would be sufficient to discover it.

3. With regard to the arrangements for use in the field it was expected from what was already known of the upper winds of India, that the general drift of the balloons would be easterly, and that descent would occur in the quadrant lying between N.E. and S.E. boundaries radiating from the place of liberation. The conditions to be satisfied in the choice of a starting place were accordingly that the country for 150 to 200 miles in the quadrant from N.E. to S.E. of it should be fairly open, flat and well populated; and Jhang in the Punjab was selected as answering to that description, being also reasonably accessible from Simla.

4. With the permission of the Local Government, and by the courteous assistance of Deputy Commissioners, the villages in several districts to the east of Jhang were informed, by means of 7,000 illustrated vernacular circulars, of the action that was to be taken by finders of instruments after descent, and of the rewards which were offered for recovery. Each instrument was to carry a label, printed in Urdu, Nagri and Gurmakhi, to remind the finder of the reward that was payable for recovery, and of the steps to be taken to secure it. In June and September 23 complete sets—consisting of balloon, instrument and in most cases parachute—were liberated, the adjustments being such that at the maximum height attainable the balloon should empty itself automatically; or, where parachutes were used, should disengage itself from the parachute and its attached recording instruments, and allow them to fall to earth. In the result it was found that the measures which had been taken for retriev-

ing instruments were considerably more successful than had been anticipated, and up to date (November 24th) 10 of the 16 instruments liberated in September have been recovered: they all afford readable records, which are now under examination.

5. **Electrical Condition of the Atmosphere.**—Considerable progress has been made with the investigations undertaken for the purpose of studying the electrical condition of the atmosphere. The apparatus which has been constructed for obtaining a continuous record of the conductivity and ionisation of the air is now in fair working order, and it is hoped that when the office has moved to its new quarters a series of curves will be obtained which will throw light on the diurnal and annual changes in these quantities, as well as upon the variations in the ionisation of the air during disturbed weather. The instrument itself is of a somewhat complicated character and has only been brought to completion after a considerable amount of experiment and change from the original design.

6. The automatic record of the electrical potential gradient in the atmosphere has led to some interesting and unexpected results, and as far as can be seen from the curves already obtained the observations made in Simla will help to explain some of the outstanding difficulties connected with the daily variation of the potential gradient. It has been found that the "fine weather potential gradient" is greatly affected by the dust which drifts up to Simla from the plains during the hot weather, large values of negative potential gradient nearly always accompanying a heavily dust laden atmosphere. Owing to several unavoidable breaks in the curves caused by bad weather and lack of a sufficiency of suitable apparatus it has been decided to postpone publication of the results until further observations have been taken.

7. An exhaustive series of measurements has been made of the electrical charges brought down by the rain during the pre-monsoon thunderstorms and during the monsoon proper. Nearly 115 rainstorms of different intensities and durations have been investigated and the quantity of electricity brought down by the rain in each two minutes was automatically registered. At the same time the number of lightning discharges and the sign of the potential gradient were also recorded. Thus simultaneous records were obtained of the four quantities: (*a*) the amount of rain, (*b*) the charge on the rain, (*c*) the number of electrical discharges, and (*d*) the sign of the potential gradient. At the time of writing the observations are being reduced and prepared for publication in the

departmental memoirs. In connexion with this work a series of experiments has been made in the laboratory at the Simla Office with the object of determining the question as to the source of the electricity which gives rise to the violent electrical discharges during thunderstorms. The results of this work appear to be very satisfactory and will be published with the discussion of the measurements of the electricity associated with the rain as soon as the discussion is completed.

8. **The question of permanent changes of climate in India.**—In view of the widespread impression that there has been a change of climate in north-west India, an examination has been made of the meteorological records with the view to ascertaining whether there has been any apparently permanent change in the amount and distribution of the rainfall over the different large areas of India. Whatever conclusions may be derived from geological or historical data it appears that no satisfactory evidence of change can be derived from the meteorological records now available.

9. Prior to 1890 the raingauges in use were of different patterns, of which some were inaccurate, and in a number of cases errors were introduced by the use of measure glasses of the wrong size: the sites also were frequently unsuitable. But none of these causes of failure were as serious probably as ignorance and carelessness on the part of the observers. If attention be confined to the stations selected in 1886 for their reliability by Mr. Blanford, and the monsoon rainfall of India be tabulated for the years 1841 up to date, it would appear from the records that there were failures of the rains in 1855 and 1848 which were as bad as, or worse than, those of 1877 and 1899, and that in a number of other early years the rains were very scanty. These results are entirely negatived by the report of the Indian Famine Commission. In confirmation of the unreliable character of the early data may be quoted the fact that the pressure measurements at Madras, Bombay and Calcutta may be trusted to give the average pressure over India for a long series of years; and that the fairly close relations which hold between the records of pressure and rainfall in the later years do not hold in the earlier.

10. At Madras the mean annual rainfall of the past 30 years has been 49″·51 while that of the previous 65 years, which may be trusted, was 48″·79; and at Bombay the mean of the past 30 years has been 72″·71 while that of the previous 31 years was 70″·21.

11. The question of the criteria to be employed before any changes of climate can be regarded as permanent has next to be considered. Of

the countries affected by the monsoon the only area for which reliable data extend over a satisfactorily long period is Egypt, where the Nile data extend back as far as 1737 except for a break from 1801 to 1884: of these records the series of 83 years from 1825 is known to be very fairly accurate since there were for almost every year at least two gauges which were simultaneously recording the river levels. Inasmuch as the Nile flood is determined by the monsoon rainfall of Abyssinia, and as the moist winds which provide this rainfall travel in the earlier portion of their movement side by side with those which ultimately reach the north of the Arabian Sea, there is a tolerably close correspondence between the abundance of the Nile flood and that of the monsoon rains of north-west India; it would thus appear legitimate to utilize the Nile data for indicating, at any rate approximately, the character of the variations to which the Indian monsoon is liable. There have been fairly long periods of deficiency followed by complete recovery. Thus in the 17 years from 1781 to 1797 the Nile was below normal in every year with one exception, and there is a series of 15 years from 1825 to 1839 all of which, except two, were in defect: the average flood of the 15 years was 8 per cent. below normal. It may thus be inferred that a shortage of rain cannot be regarded as establishing a permanent change of climate unless it extends over thirty years at the very least. The means for the last thirty years of the first class observatories cannot be quoted in favour of a permanent change; and apart from these the number of years for which reliable data exist is unhappily only about forty, so that even if the last twenty years were to differ materially from the first twenty, it would not be sufficient to establish a permanent change.

12. Tabulations have been effected of the rainfall of the separate provinces, beginning at the earliest year for which a satisfactory number of stations are available and ending at 1907; and records of the same stations have been considered throughout the period in order to avoid introducing fortuitous changes into the rainfall of the province by adding stations whose normal rainfall may have differed from that of the stations already employed. The monsoon rainfall of the Punjab, Rajputana, and Gujarat increased to a maximum in 1893 or 1894, diminished to a minimum in 1899 and since then has in general improved. In Bombay and Central India there has been on the whole a slight diminution in rainfall. In the United and the Central Provinces, Hyderabad, Mysore, Madras, Bengal, Eastern Bengal and Assam, and Burma, there is no appreciable indication of climatic change. When seeking an explanation

of these changes in north-west India, the maximum in 1893-4 and the minimum in 1899 appear to negative any explanation in terms of a factor of steadily increasing importance such as the increase of irrigation. The direct influence of forests upon rainfall is, I believe, almost universally regarded by specialists as small; and it seems impossible to explain the character of the variations of rainfall during the past twenty years in terms of it.

13. One other explanation has still to be considered. A statistical examination of the data of the monsoon rainfall and the temperature and pressure of India in May shows that these Indian conditions have no perceptible influence; but conditions in the south Indian Ocean, where the monsoon winds take their origin, and in the subequatorial region have a considerable effect. It would, therefore, seem natural to ascertain whether the tendencies in question have not been associated with abnormal features south of the equator. And as the changes in India are confined to the northern half of the field of the Arabian Sea current it would seem natural if this cause be the true one to expect corresponding changes in Abyssinian rainfall and in the height of the Nile. Such is in fact the case. In the Nile, as in north-west India, there was a rise to a maximum in 1894 followed by a rapid fall to 1899, since which time to 1907 a marked deficiency has prevailed. This latter period has been associated with abnormally large ascensional movement at the equator, with high pressure in the Indian Ocean and low pressure in South America. Thus it seems natural to attribute the variations in north-west India to unusual features in the larger movements in the atmosphere and not to any local causes in India.

14. **Publications.**—In addition to the Daily Weather Reports published at Simla, Calcutta, Bombay, and Madras, the Monthly Weather Reviews, the Annual Summary, and various administrative pamphlets the following memoirs have been published departmentally:—

(1) A discussion of the anemographic observations recorded at Allahabad from September 1890 to August 1904, and a discussion of the anemographic observations recorded at Lucknow from July 1878 to October 1892, by Sir John Eliot, M.A., F.R.S., K.C.I.E., late Meteorological Reporter to the Government of India and Director General of Indian Observatories. (Memoirs of the Indian Meteorological Department, Vol. XVIII, Part III.)

(2) Kite flights made at Belgaum during pre-monsoon and monsoon periods in 1906, by J. H. Field, M.A., Imperial Meteorologist. (Memoirs of the Indian Meteorological Department, Vol. XX, Part II.)

(3) Types of Weather in Madras. By R. Ll. Jones, M.A., Meteorologist, Madras. (Memoirs of the Indian Meteorological Department, Vol. XX, Part IV.)

(4) A discussion of some of the anemographic observations recorded at Madras. By R. Ll. Jones, M.A., Meteorologist, Madras. (Memoirs of the Indian Meteorological Department, Vol. XX, Part V.)

The Meteorological Atlas of the Indian Ocean north of latitude 12°S., which had been prepared, chiefly by Mr. Dallas, has been published by Messrs. Bartholomew. It contains monthly normal charts of the pressure, winds and sea currents, as well as charts showing the tracks of storms and the pressure and wind conditions prevailing during selected typical storms.

TERRESTRIAL MAGNETISM.

BY

GILBERT T. WALKER, M.A., Sc.D., F.R.S.,
Director-General of Observatories.

Magnetic Observatories.—*Bombay (Colaba and Alibagh).*—Further progress has been made by the Director, Mr. N. A. F. Moos, with the computing and discussion of the sixty years' series of magnetic observations at Colaba, and these should shortly be complete. The work of printing has begun.

2. *Dehra Dun, Kodaikanal, Barrackpore and Toungoo.*—These observatories were started as base stations in connection with the Magnetic Survey of India and are all equipped with Watson autographic instruments for declination, horizontal intensity and vertical force. Instead of dip circles earth-inductors of the Schulze pattern have been set up at each observatory. All the instruments have given good results through the year with the exception of the vertical force instrument which was erected at Kodaikanal over a year ago and had previously given trouble :

a new magnet was fitted but the instrument still appeared unstable. The dip at Kodaikanal is only about $3\frac{1}{2}°$ and the force to be measured extremely small; it was therefore considered advisable to make the magnet more stable by lowering the small gravity bob, and excellent results are now being obtained. The temperature co-efficients of the new vertical force instruments mounted at Barrackpore and Kodaikanal in December 1907 were satisfactorily determined as $-3{\cdot}0\gamma$ and $+5{\cdot}2\gamma$ per 1° F. respectively. The base mirror of the declination magnetograph at Barrackpore had been attacked by fungoidal growth and it has been renewed. The mean values of the magnetic elements for 1907 at the observatories are as follows:—

	Declination.	Horizontal Force.	Vertical Force.	Dip.
Bombay . .	1° 3′·8 E.	·36862	·15843	23°·14′·5N.
Dehra Dun .	2°·38′·3 E.	·33324	·31736	43°·36′·1N.
Barackpore .	1° 9′·9 E	·37288	·21967	30°·30′·2N.
Kodaikanal .	3°·40′·7W.	·37431	·02259	3°·27′·2N.
Toungoo .	0°·39′·3 E.	·38754	·16461	23° ·0′·7N.

3. Magnetic Survey.—The preliminary survey of India for which sanction was given was to involve:—

(*a*) Observations for declination, intensity and dip at about 1,100 stations, whose distance apart was to be comparable with 35 or 40 miles, the "density" being one station to 1,300 square miles.

(*b*) Observations in successive years of the magnetic elements at 23 "repeat stations" in order to make possible the elimination of secular variation.

(*c*) Data from absolute and self-registering instruments at Bombay and the four special base stations already mentioned.

A beginning was made with field work in November 1901 and the operations up to the end of the year 1906-07 have been described in previous reports: by that time 1,110 stations had been occupied and 22 repeat stations established, in addition to 25 stations on the Seistan trade route where declination had been observed. During the year 1907-08 the preliminary survey was continued by four detachments, three being employed in Burma, while the fourth was occupied in filling in gaps in Berar, Orissa and Assam. One of the Burma detachments was withdrawn from magnetic work for three months in order to carry out some triangulation for the Chin-Lushai-Arakan boundary, and another, owing to the early break of the monsoon in south Burma, could not complete its programme. For these reasons the outturn of new stations, 80, was small compared with the 152 stations of the previous year.

The field season commenced on the 21st October, 1907, and the party proceeded to recess quarters on the 4th May 1908. The total number of stations occupied to date is 1,214 with 22 repeat stations; observations have also been repeated at 31 old field stations.

Captain R. H. Thomas, R.E., was in charge up to the 31st March 1908, and Lieut. H. I. Couchman, R.E., after that date; Lieut. H. T. Morshed, R.E., was posted to the party in August 1908.

4. The Officer in charge, with his assistant, took observations at all the repeat stations and also at several old field stations, with a view to obtaining further values of the secular change in the magnetic elements. Comparative observations were also taken at the four observatories of the Survey, and at Alibag, to determine the differences from the Survey standard instruments at Dehra Dun.

5. During the recess season the computation of the field work and the reduction and tabulation of the base station results for 1907 have been completed. The whole of the H. F. observations taken since the beginning of the survey have been recomputed by applying mean values of m (the amount of the magnet) to the value of m H obtained in the deflection observation. These mean values of m have been obtained by dividing the values into groups and taking means of groups. Where the means of several groups agree a further mean has been taken, and where not the individual values have been carefully scrutinized to discover when the change occurred. This recomputation was undertaken originally to improve the monthly mean values of the base lines of H. F. magnetographs, and as this was achieved, the method has been extended

to all H. F. observations, and has provided new values of the instrumental differences, which will be used in the reduction.

Charts have been prepared showing the Indian isomagnetics (lines of equal declination, dip and horizontal force). These charts will be useful in indicating the more obviously disturbed areas, but as they are based on uncorrected observations they can only be considered as approximate.

The correction of the horizontal force and declination observations for diurnal variation and instrumental difference is being started, the repeat stations being dealt with first. The correction to be applied for diurnal variation will be computed by the latitude formula mentioned in the last report, using the diurnal variation figures of the three nearest base stations, and taking a mean of the two values of the correction found. With regard to the instrumental correction in horizontal force, since the correction to be applied bears a constant ratio to the force as measured, its amount will vary slightly over the area of the survey.

Investigations into the question of the correction for disturbance are still being made, but no satisfactory empirical formula connecting these corrections at the base stations has as yet been discovered, and it would seem that an approximate correction will have to suffice, at any rate for the horizontal force observations.

6. During the next field season it is intended to begin the detail survey by examining a few of the more obviously disturbed districts in Rajputana and Central India. One such district occurs near Pokaran, in the Rajputana desert, where the declination alters by 3° in 40 miles, while another lies near the Nerbudda river, south-west of Indore, where values of horizontal force of ·32 C. G. S. and ·38 C. G. S. have been found at contiguous stations 35 miles apart, the normal value of the district being about ·365 C. G. S. It is considered advisable to commence the detail survey in these abnormal localities, in order to gain experience in selecting stations which will reveal the loci of disturbance, and not to attempt as yet to pourtray the geological features of a district which has not been shown as obviously abnormal by the uncorrected observations of the preliminary survey. The survey of the northern edge of the Deccan trap, mentioned in last year's report, will therefore be left for the present. Two detachments will be available for the detail survey throughout the field season. Two others will be employed in completing the preliminary survey of the coast of Burma for the greater part of the season, and will then assist in the detail survey.

GEOLOGY.

BY

SIR THOMAS H. HOLLAND, K.C.I.E., D.Sc., F.R.S.,

Director, Geological Survey of India.

CONTENTS.

INTRODUCTION.

The geological results summarised below include those available for publication up to the end of the year 1907. The results obtained during the remainder of the field season have still to be supplemented by

work in the Laboratory before their value can be safely estimated. In addition to the questions for research included in the programmes published with the Annual Reports of the Board for 1906-07 and previous years, it will be noticed that certain results of special interest have been obtained as bye-products during the course of the sanctioned surveys and enquiries of economic importance.

GEOLOGICAL SURVEYS.

Central India.

Area surveyed.

The officers in the field continued the survey in a general westerly direction from the area done last year, with the result that the following Standard Sheets on the 1″ = 1 mile scale have now been added to the completed list:—Nos. 212, 276, 277, 306 and 334; whilst portions of the following have been mapped:—Nos. 211, 213, 242, 243, 244, 274, 275, 303, 304 and 335. Of these the western area, included in Nos. 211, 212, 213, 242, 243 and 244, was surveyed by Messrs. Walker and Heron, and the eastern area, included in Nos. 274, 275, 276, 277, 303, 304, 306 and 334, by M. M. Ry. Sethu Rama Rau. The latter also entered sheet 335, and revised portions of it with special reference to the iron-ores of the Sendrani neighbourhood.

Connection with previous surveys.

Omitting areas belonging to the Gwalior State, the Central India survey has now linked up with the previous survey of the Lower Narbada valley by Mr. Bose (*Mem. Geol. Surv. Ind.*, Vol. XXI, Pt. 1, 1884) and with that of the Dhar State by Mr. Vredenburg, all of which region lies to the south and south-west of the area just completed. During the present field season it is hoped similarly to link up (with possible revision) with the areas mapped by Messrs. Hacket and Kishen Singh, which lie to the west and north-west of the area now in progress.

Western Area.

The western area surveyed by Messrs. Walker and Heron lies within lat. 22° 30′—23° 30′ and long. 74° 30′—75° 20′. This area included the whole of the Pitlawad pargana of the Indore State, the greater portion of the Jhábua State and parts of Rutlam State.

Disposition of Rock Formations.

Rocks of the Arávalli series occupy the south-western corner and a portion of the western side of this area, which lies entirely in Jhábua territory. Along the southern and a part of the eastern margin of this Arávalli outcrop, platforms of Lameta beds lie horizontally and unconformably on the schists and granites. The remainder of the country surveyed is occupied entirely by Deccan Traps.

The Aravalli Series.

The position of an outcrop of Arávalli rocks as an inset in the margin of the Deccan Trap leads one to infer that it was at one time covered by Deccan Trap. This view is strengthened by the fact that several rivers which flow from the basalts on to the Arávallis have cut back the former and exposed tongues of the latter. The sameness in the general maximum level of the Arávalli rocks is what one would expect as a result of the removal of the basalts. Streams have cut up the surface into low, round-backed hills. The chief rock types represented are—Sericitoid-phyllites, quartzites, quartz-schists, granites and limestones. Locally gneisses are met with. Mr. Walker notes that many of the granites contain large quantities of pale-brown sphene. In the west (Walker), and also in the east (Heron), the occurrence of an amphibole-quartz-rock in conjunction with granite masses has been described. Further it has been found that in one place in the west the above rock passes into an amphibolite. Actinolite also is an occasional constituent in this series (Walker). A more definite relationship of amphibole rock to granite could not be determined owing to the occurrences being much obscured by soil. The limestones are interesting; for Mr. Heron reports one containing green epidote, and another, found in the west, has such an amount of sericitoid material as to warrant it being named a calc-schist. Throughout the Arávalli series the predominant characteristic is the exceeding acidity of the rocks. The phyllites have well developed white quartz lenticles and veins, and even the limestones are thickly traversed by veins of quartz. Muscovite is the chief mica in the granites; biotite is not common. To the north of the outcrop and along its eastern face the general strike is E 20°—30° S. This changes to S 20° E. in the south and west. The rocks are much folded, often steeply, and the dips are high, irregular, and often vertical. The phyllites still preserve traces of bedding, and the granites also retain to a large extent their original structure.

The Lameta Series.

As in the case of the Arávalli series, the Lameta rocks are exposed only in Jhábua State. The peculiar distribution of these rocks is worthy of note. One small isolated patch of Lameta rocks was found lying horizontally and unconformably on the Arávallis at the northern end of the exposure. They occur fringing the margins of the Deccan Trap outliers in the neighbourhood of Jhábua City, but do not underlie the margin of the main basalt flow in this area. A few miles to the south the Lametas crop out between the Arávalli rocks and basalts. From this point they crop out almost without break; and to the south of the Arávalli exposures they form platforms of large extent. Not only is the distribution peculiar, but so is the change in lithological character. The northern exposures are of the type previously referred to as Lameta; being described as generally calcareous, pale in colour, containing much sandy admixture, occasionally cherty, and with an uppermost layer characterised by well-rounded pebbles of quartz, quartzite, and bright-red jasper (*Rec. Geol. Surv. Ind.*, XXXV, p. 55).

As one follows the outcrop to the south, one finds a great increase in the conglomerate beds. Grits occur very frequently, and locally the rocks are entirely silicified and very cherty. In places fossiliferous, siliceous limestones were found and a few patches of true fossil-limestone were discovered. Among the fossils found were specimens of *Rhynchonella*, *Terebratula*, *Ostrea*, several genera of *Lamellibranchiata*, *Gastropoda* and *Bryzoa* (Walker). Thus, in this area a change similar to that described by Mr. Vredenburg in the Dhar Forest [1]—from beds of estuarine type (Lameta) to those of marine type (Bágh) has been seen.

Mr. Heron notes that near Dhandalpura a bed of coarse grit occurs which is burnt by the basalt capping it. This bed is in small gentle folds. Mr. Walker also remarks on an outcrop of Lameta limestone to the south of Piplade where dips of 4° were measured. Cases in which the Bágh beds have been eroded [2] previous to the outflow of the basalts and in which the basalts rest immediately on the Aráballis and at a lower level than the surrounding Bágh beds, have been described (Walker). The base of the series has not been seen, but the maximum thickness developed in this area appears to be not more than 30 feet.

[1] General Report, *Geol. Surv. Ind.*, for 1902-03, p. 20.

[2] Geology of India, 2nd Ed., p. 275.

Deccan Trap.

Although the major portion of the area surveyed during the field season is occupied by Deccan Trap, very little new information concerning these enormous masses has been obtained. Three beds of what appears to be fragmental volcanic ejecta were found intercalated with the normal basalts of the Deccan Trap. The uppermost one is near the top of Kukinda hill (Jhábua State) at a height of 1,450 feet (Walker). The other two occur to the N.E. in the Pitlawad pargana of the Indore State. The upper one of these is at a height of 1,300 feet, is about 3 feet thick and is the middle member of the basalt series forming the small hills surrounding Bamnia Railway Station. The lower is to be met with in the bed of the Larki river at Pitlawad town and in the neighbouring streams. The bed, which is between 4 and 5 feet thick, consists of small angular blocks of the normal vesicular and amygdaloidal basalt of the district, in a matrix of finer materials; the whole is much decomposed, contains numerous cavities lined with calcite and various zeolites, and is in many places stained red and green. These two beds have been found at intervals over an area of about 130 square miles, the approximate centre of which is Pitlawad town.[1]

A small lenticular sill of quartz-felsite was found near Banri (Walker). An interesting dyke was found at Patbarli. The dyke-rock is an augite-plagioclose rock and shows ophitic structure (Heron). Olivine has not been met with during the course of the season's work.

Alluvium and Soil.

Except on the Malwa plateau the rivers and streams run for the most part in rocky beds with local bands of drift pebbles, and pebbly conglomerates. In places along the Mahi river shelves of alluvium 20 feet in thickness are to be found. On the Malwa plateau the streams run most frequently between banks of cotton soil and kankar-gravel. The soil on the Arávallis and Lametas is thin and poor and exceedingly quartzitic. The phyllites give thicker and more argillaceous soil, but this is usually impoverished by the admixture of large quantities of quartz. On the slopes of the ghâts the soil is red and scanty, and thickly littered with trap fragments. In the flatter valleys and on the Malwa plateau there is usually a fair thickness of grey and black cotton soil. To the north and east of Rutlam town the soil is very thick and there are few rock exposures. However, water can be obtained from wells at depths between 30 and 40 feet, even at the end of the dry season (Heron).

[1] Mr. Middlemiss thinks the agglomeratic character of these beds may have been acquired by movement in a partially and irregularly consolidated flow of trap.

Economic Geology.

The examination of the previously-named portions of the Indore and Rutlam States has shown that there are no deposits of minerals of economic value; and concerning Jhábua State it has been found that the Arávalli series includes the only rocks that carry mineral deposits.

Manganese-ore.

The undermentioned known deposits were visited:—At Amlamál the manganese-ore occurs as psilomelane in a fine-grained spessartite-quartz rock. The lode is thin and is ill-defined and the ore is mixed with quartz. The manganese-ore at Tumdia is found in veins and lenticles of white quartz, the surrounding rocks being sericitoid phyllites. The ore-bearing band is between 2 and 3 feet in thickness and about 200 yards long. In parts the ore is good, but on the whole is too quartzitic.

At Pipal Kotha, which lies midway between the manganese mines of Kájlidongri and Rambhapur, there are two outcrops, in line, of a pale-lavender coloured quartzite carrying an ore-band of psilomelane mixed with pyrolusite. The outcrop is never more than one yard wide and the total length exposed is about 100 yards. The ore is of good quality, but there is too large a percentage of quartz for the deposit to be of economic value. Two deposits of manganese-ore and one of an iron-manganese-ore were found in the Pitol district. All of these are small and poor in quality. Traces of manganese-ore were found in five other places. These were usually pyrolusite in the white quartz veins of the phyllite series.

Mica.

Reported deposits of mica occurring near Kanás and Ránápur were found to be derived from medium-grained pegmatite veins. They are of no value.

Iron-ore.

The ironstone deposit at Piplade, and also that in the Sánár river between Parwet and Gadwara, are too small and of too low a quality to admit of successful working.

A supposed China-clay from Ránápur is a fine-grained, white, siliceous limestone.

Eastern area.

The eastern area surveyed by Sub-Assistant M. M. Ry. Sethu Rama Rau lies entirely within lat. 22° 30′—23° 30′ and long. 75° 30′—76° 30′, and is contained in the Mehidpur, Indore and Nimawar districts of the state of Indore. It embraces irregular areas of the Malwa plateau of Deccan Trap stretching north and north-east of Mhow, and a narrower area to the east of Mhow, where the Malwa plateau descends in a southerly direc-

tion by three fairly well-marked terraces or scarps to the lowlands of the Narbada valley. The range of altitude is between 2,100 and 950 feet. It is only in the area to the east of Mhow that formations older than the Deccan Trap emerge from beneath the latter in the wide valley of the Narbada.

Older formations: Archæan, Bijawar and Vindhyan.

The older formations form part of the same complex which further west has been recently mapped in detail by Messrs. Vredenburg and Fermor (see General Report, Geol. Surv. of India for 1902-1903, p. 20), following on the older survey of Blanford (*Mem., Geol. Surv. Ind.*, Vol. VI, Pt. 3, 1869) and Bose (*Mem., G. S. I.*, Vol. XXI, Pt. 1). Of these the Archæans are represented by granitic and mottled hornblendic gneiss, and hornblende-chlorite schists, exposed to the east of Satwas and occupying the low country between the base of the Deccan Trap and the Narbada river as far as the limits of sheets 334 and 335 go in that direction; the foliation strike being N. 10° W.—S. 10° E. near Kathargaon and Bagda, but near the Narbada being nearly E.—W. The Archæans are traversed by many doleritic dykes which near Kathargaon generally keep a direction N.W.—S.E. They are crystalline and fine-grained, and with semi-glassy selvages, and appear to be different to the basalts, etc., of the Deccan Trap. Quartz veins also traverse the gneiss, in some of which, such as those at Tamkhan,[1] copper pyrites with malachite alteration products are present, and also iron pyrites. The Tamkhan veins run N.—S. and are 4-5 feet thick and about ½ mile long. They are situated on the Narbada (lat. 22° 28′, long. 76° 52′) and were quarried and smelted about 150—200 years ago by the ruling chiefs. The pits are now filled in with fallen material and it was impossible to learn whether the whole of the ore-body had been worked out or not, but the sides of the vein seem to have been richer in pyrites than the middle. Other veins between Kharia and Jinwani (lat. 22° 19′, long. 76° 45′) also run nearly N.—S. and show tourmaline and a few copper stains, but pyrites is not seen *in situ*. The exposures were however very jungle-covered. No gold was found in these quartz veins.

Copper-ore.

The Bijawars in sheets 334 and 335 occur firstly as inliers in the form of small hills rising from among the basal bed of the Deccan Trap, as seen in the neighbourhood of Sukras (22° 40′, 76° 52′), and secondly further south forming an L-shaped

Bijawars.

[1] Referred to by P. N. Bose, *loc. cit.*, p. 69.

outcrop among the Archæans between Sendrani (22° 28′; 76° 40′) and Piplia on the Narbada. The lower division, consisting of coarse upper and fine conglomeratic quartzites, is exposed in the Sukras area, and the division of brecciated jaspideous quartzite and cherty limestones in the Sendrani-Piplia area. The upper division is said to lie unconformably upon the Archæans, but the brecciated bands, always found at the junction with the granitic gneisses in the southern area, might be understood to indicate an intrusive action of the Archæans. The problem here appears to be a repetition of what is found in other parts of India where similar rocks occur; and the apparent irrationalities of the dip indications are also not in favour of a simple superposition theory for the Bijawars.

Vindhyans.

A system of sandstones, shales and conglomerates occurring as inliers among the basal bed of the Deccan Trap, and also as a large connected outcrop to the west of Satwas, probably belong to the Vindhyan system and perhaps to the Lower Vindhyans. They are inclined at moderate angles, generally towards the south-west. Their exact horizon is not yet clear. Bose has marked them as Upper Vindhyan, whilst Vredenburg has marked their western extension as Lower Vindhyan.

Deccan Trap, etc.

As seen in sheet 324, the Deccan Trap begins with a lowermost bed which occupies the flat plains for several miles before the upper beds which compose the scarp appear. This lower bed makes no special orographical feature with the older rocks of the Vindhyans, Bijawars and Archæans, above which it is described as lying unconformably, and without the intervention of any Lametas, such as occur in other neighbouring areas to the west. Above this the scarped edge of the Malwa plateau rises more than 1,000 feet in beds of softer and harder Deccan Trap, some of which are columnar, and some containing the usual geodes full of siliceous or zeolitic material. Deccan Trap occupies the rest of the country surveyed, with the exception of a very few cappings of laterite, some further exposures of the subrecent calcareous concrete noticed in the last General Report (*Rec. Geol. Surv. Ind.*, XXXV, 57), together with alluvial stretches in the valley systems, cotton soil and calcareous tufa.

Sendrani Iron-ores.

The Sendrani (22° 28′; 76° 40′) iron-ores were specially investigated, and the positions of the old mines recorded on the map by Sethu Rama Rau. The ores were found to be exposed in ancient pits at several places scattered over the

Bijawar area to the south and south-east of Satwas, and also along the junction between the Bijawars and the Vindhyans. The original rock appears to have been a hæmatitic shale at the base of the latter, but the ore also occurs lining hollows and fissures in the underlying Bijawar breccia, from which it has again been accumulated in the form of nodules and lumps scattered about in the disintegrated surface rock. In competition with imported iron the industry has gradually died out in later years.

Central Provinces.

During the field season Mr. P. N. Datta completed a survey of the previously unmapped areas in the Bhandara district. The only features of geological interest deserving special mention are the large outcrops of post-Vindhyan diabase, possibly connected with the Deccan Trap eruptions, and the sections which clearly show the great unconformity between the Vindhyan sandstones and the vertical beds of Dharwar schists below. No fossils were obtained from the Gondwana rocks exposed in Bhandara and adjoining parts of Chanda, and no new occurrences of valuable minerals were recorded.

Burma.

Surveys carried out in the oil-fields of Minbu, Magwe, Myingyan and Pakokku districts are referred to under *Petroleum*, while the exploratory work done in Mergui is reviewed under *Tin-ore*.

Northern Shan States.

The survey of the Northern Shan States was continued by Messrs. T. D. LaTouche and J. Coggin Brown in two separate areas, (*i*) that comprised in Sheets 331 and 332 of the one-inch Topographical Survey, lying along the valley of the Nam-Tu above Hsipaw, and including the tract north of Sheet 331 in which the silver-lead mines of Bawdwin are situate, which has not yet been surveyed on the one-inch scale; and (*ii*) the hill ranges between the Shan plateau and the Salween extending southwards from the Loi-len range E. of Lashio to the plains of Kehsi Mansam in the Southern Shan States, comprised in Sheets 433, 434, 435, and 436 of the one-inch survey. The whole area mapped was about 3,300 square miles.

The geology of the Nam-Tu valley had previously been studied by Messrs. Datta and Pilgrim, and to some extent by Mr. LaTouche, but

Mr. Datta had confined his attention mainly to the upper Palæozoic and Mesozoic rocks, and the discovery of hitherto unrecorded beds containing characteristic fossils has necessitated several changes in the mapping of the boundaries laid down by Mr. Pilgrim. The most interesting of these discoveries was that of a band containing graptolites, of the same type as those which had been found during the previous season in the Kehsi Mansam district at the base of the Namhsim sandstones at Panghsapyé, a village about 8 miles north-west of Hsipaw. These graptolites are of quite a different type from those of the Zebingyi beds, described by Mr. Cowper Reed in the *Palæontologia Indica*, and belong to an older horizon, probably of Llandovery age. The beds in which they are found immediately overlie a band of purple shales, which was formerly considered as the base of the Silurian Namhsim sandstones, but the graptolite zone must belong to the much greater thickness of purple and grey shales found last year on the eastern flanks of the Loi Twang range in Kehsi Mansam, from which Ordovician trilobites were obtained. The purple band of Panghsapyé and the neighbourhood must therefore be considered as the uppermost member of the Naungkangyi group of beds. There is no apparent unconformity in the Nam-Tu valley between the Naungkangyi beds, Purple band, Graptolite band, and Namhsim sandstones, and if the graptolites (which have not yet been examined by a trained palæontologist) should turn out to be Llandovery forms, we should have here a complete succession from Lower Ordovician to Silurian strata.

The Graptolite and Purple bands were traced northwards from Panghsapyé across Sheet 331 and were of great assistance in mapping the boundaries of the formations. The Purple band also extends from Panghsapyé to the south-west as far as the head of the Gokteik Gorge, but the Graptolite band above it appears to be absent in this direction, or at any rate has not yet been detected. It is for this reason that the connection of the Purple band with the Naungkangyi beds below was not previously recognised.

Along the gorge of the Nam-Tu above Hsipaw the succession of the rocks is normal, the Naungkangyi beds occurring along the slopes of the valley on the west side and in the bed of the river, followed at the base of the precipitous scarp on the east side by the Purple and Graptolite bands. These are succeeded by the Namhsim sandstones, which form the whole of the scarp overhanging the river, and are capped by the Plateau limestone, which forms a strip of undulating, high ground

parallel to the gorge, and in its turn disappears to the east beneath the red sandstones of the Namyau series, the dips throughout being easterly. But to the west of the river the Naungkangyi beds, instead of being followed by the older unfossiliferous rocks of the Chaung-Magyi series, are found overlying, with apparent conformity, a series of sandstones in which Namhsim fossils, among others *Orthonota* and *Encrinurus*, have been found. The boundary line is almost straight, running nearly due north and south, and it is evident that the Naungkangyis have been pushed up along the line of a fault above the sandstones. Within a few miles to the west the dip of the sandstones becomes less, and their lower beds are found resting quite unconformably upon the upturned edges of the Chaung-Magyi rocks, entirely overlapping the Naungkangyis.

The great fault mentioned above has been traced northwards into the Bawdwin area, where it inclines somewhat to the west of north and, leaving the fossiliferous Palæozoic rocks, traverses the rhyolitic tuffs and rhyolites of Bawdwin, which form the uppermost member of the Chaung-Magyi series. To the intense crushing and disturbance caused by this great dislocation is probably due the opportunity for the mineralization of the Bawdwin rocks. A separate report on this subject will be published in the *Records, Geol. Surv. of India*.

The geology of the hill-ranges east of the plateau, though in general sequence similar to that of the western portion of the Shan plateau, exhibits several important differences in detail. The low ground separating the various ranges is invariably occupied by the Plateau limestone, with an occasional outlier of the red Namyau sandstone, or of the Tertiary coal-measures, resting upon it. The limestone tracts invariably present the same aspect of undulating, thinly-wooded plateau, generally at a lower elevation than the older rocks forming the core of the ranges, but sometimes rising on their flanks into precipitous scarps facing the axis of the range, or in some cases arching completely over them, thus proving that the limestones participated in the orogenic movements resulting in the elevation of the ranges. The structure of these is similar in all cases, consisting of an elongated dome, more or less modified by subsequent faulting. In the centre of each dome is a core of ancient rocks, belonging to the Chaung-Magyi series, and generally forming the highest elevations. The great mass of Loi Ling, the highest peak in the North Shan States, rising to 8,771 feet above the sea, is entirely formed of these rocks. Along the flanks of the core is found a zone occupied by the lower Palæozoic fossiliferous rocks, but the facies of

these is not quite the same as in the western sections. The Naungkangyis are reduced to a band of calcareous sandstones of no great thickness (with *Rafinesquina* and other characteristic fossils belonging to that group), whereas the thickness of the overlying purple shales is enormously increased. These latter beds in this area probably include a portion of the Naungkangyi group of the western sections, since they contain *Pliomera insangensis* Reed, one of the characteristic trilobites of the upper Naungkangyis, but the fossils from the purple beds have not yet been determined. They include many large trilobites belonging to the *Asaphidæ*, as well as *Ampyx*, *Bronteus*, etc.

The Graptolite band of Panghsapyé has been found in several localities overlying the purple shales, and has helped considerably in unravelling the complicated structure of these ranges. The great development of sandstones (Namhsim sandstone) which succeeds it on the Nam-tu appears to be absent, but some marly beds, which are found at the top of the sandstones in the west, are found in places immediately below the Plateau limestone, and appear to be the only representatives of the Silurians in this area.

At the top of the Chaung-Magyi series, and immediately underlying the Naungkangyi beds, a series of volcanic ash beds, with thin flows of rhyolite, were found in several localities among these ranges. These correspond closely, both in position and petrological characters, with the tuffs and rhyolites of Bawdwin. In some places a conglomerate of well-rolled pebbles occurs at their base, apparently shore deposits, accumulated in the interval between the consolidation of the Chaung-Magyi rocks and the beginning of the Naungkangyi epoch. The blocks of quartz-porphyry, noted by Dr. Noetling in the bed of the Namma river, in his account of the coalfields of the North Shan States (*Rec., Geol. Surv. Ind.*, Vol. XXIV, Pt. 2, p. 110) are derived from these beds, which occur at the crest of the range east of Lashio, on the north side of the Nampawng, a tributary of the Namma.

As the survey of this area may be interrupted by urgent requests elsewhere, it may be desirable to summarise the chief stratigraphical results obtained by Mr. LaTouche and his colleagues. The geological reconnaissance has now been carried over 24 sheets of the one-inch map covering an area of 13,000 square miles, though much still remains to be done in working out the details of the geological structure of the plateau and its surroundings.

The formations that have been identified by means of their fossils, with their European equivalents, are the following:—

Local names.	European equivalents.
Late Tertiary freshwater silts with coal, Lashio, Namma, etc.	Late Pliocene or Pleistocene.
Namyau beds,—Red sandstones with bands of limestone near base	Jurassic (exact horizon not yet known).
Napeng Shales	Rhætic.
Fusulina and Productus Limestone	Permo-Carboniferous.
Plateau Limestone	Carboniferous and Devonian.
Zebingyi graptolite beds	Silurian.
Konghsa Marls	
Namhsim Sandstones	
Panghsapyé graptolite band	Ordovician.
Hwe Mawng Purple Shales	
Naungkangyi beds	
Chaung-Magyi series	? Cambrian.
Archæan schists and gneisses.	

The Chaung-Magyi series is composed of slaty shales and quartzites, which may be of Cambrian age, but in which no fossils have as yet been found; these rocks rest upon the Archæan mica-schists and gneisses of the Ruby-Mines District.

In Ordovician and subsequent times the older rocks, the Archæan gneisses and mica-schists, with the Chaung-Magyi series, formed a tract of land, extending along the north-western border of the position now occupied by the Shan plateau, with perhaps a few islands, composed of similar rocks, to the south-east of the old coast line. Along the borders of these land areas the Ordovician and Silurian rocks were deposited, followed by a great accumulation of reef deposits, now represented by the limestones covering the greater portion of the plateau, and extending to the south at least as far as Tenasserim. This period closed with the deposition of limestones containing *Fusulina* and *Productus*, probably contemporaneous with the Middle Productus Group of the Salt Range.

The succeeding formation, the Napeng Shales, has been found to contain a peculiar fauna, consisting almost exclusively of Lamellibranchs, of Rhætic age. These shales apparently filled up hollows in the plateau limestone, either due to original inequalities in its surface, or to irregular solution of the limestone during the period that had elapsed since its deposition. Another break then occurred, during which denudation of the

limestone took place, indicated by the presence of conglomerates, with pebbles derived from it, at the base of the succeeding formation. This latter, the Namyau series, consists of red sandstones, interstratified in their lower portion with bands of limestones containing Jurassic fossils. Hitherto no fossils have been found in the upper portion of this series, and it is uncertain whether any part of the Cretaceous period is represented.

After the accumulation of the Namyau beds marine deposition ceased entirely over the whole area, none of the lower or middle Tertiary formations being present. In all probability the great earth-movements at the opening of the Tertiary period converted the whole of Burma east of the Irrawadi and Sittang valleys into dry land, subject to aërial denudation, and the late Tertiary silts with coal, occupying a series of basins surrounding Loi Ling, the highest ground in the States, were evidently deposited after the main drainage features of the plateau had been marked out. Indeed, these beds of silt may be of Pleistocene, or even sub-recent age.

It is somewhat surprising that igneous rocks are of extremely rare occurrence over the whole of this area. The ancient rocks near Mogok (Ruby-Mines) are traversed by great bands of granite, and there are indications of volcanic conditions, consisting of rhyolites and rhyolitic tuffs, along the borders of the Ordovician land surface; but throughout the whole sequence of Palæozoic and Mesozoic strata there are no traces whatever of volcanic activity. In late Tertiary times there was, however, a feeble manifestation of these agencies, for in one locality the silts were found to be traversed by dykes of basalt, resembling that of the sub-recent volcano of Hawshuenshan, near Tenghueh (Momein), in south-west Yunnan.

Mount Popa, Myingyan district.

Mr. E. H. Pascoe has made a geological reconnaissance of the volcanic region of Popa in the Myingyan district [Programme for 1907-08 (4)], and has outlined a scheme for more systematic survey during the current field season.

Mineralogy.

New Group of Manganates.

During the course of his exhaustive study of the manganese-ore deposits of India, which will shortly be described in a memoir now in the press, Mr. L. L. Fermor has made special studies of certain new minerals that have been

discovered. In studying the constitution and relations of the ill-defined species psilomelane, he concludes that there is now enough material to distinguish as a special family the manganates of barium, lead and other bases, corresponding to the hypothetical acid H_4MnO_5. In this family occur, besides the amorphous *psilomelane*, the fibrous lead-manganate described by W. Lindgren and W. F. Hillebrand in 1904[1] as *coronadite*, and the barium-iron manganate, *hollandite*, originally found at Kajlidongri, Central India, and afterwards obtained at various localities in the Central Provinces and largely worked at Sitapar, Chhindwara district, for export as an ore of manganese. The chemical constitution of these minerals is discussed in a special paper published in *Records, Geol. Surv. Ind.*, Vol. XXXVI, Part 4.

An account of the mode of occurrence of manganite in the Sandur State, with a discussion of the origin of the mineral has been published by Mr. A. Ghose (*Trans., Manchester Geol. and Mining Society*, Vol. XXX, p. 307, 1908.)

Petrology.

Jadeite deposits, Myitkyina district.

An interesting investigation of the valuable jadeite-deposits in the Myitkyina district, Upper Burma, was undertaken by Dr. A. W. G. Bleeck. The full results are published as a separate paper in volume XXXVI of the *Record, Geol. Survey*. Dr. Bleeck examined the jadeite occurrences at three localities in the Kachin hills, namely, Tawmaw, Hwéka and Mamon. At Tawmaw he describes the mineral as occurring in a metamorphosed igneous dyke, intruded into serpentine. He concludes that the jadeite is the result of the metamorphism of an albite-nepheline rock originally forming the dyke, both minerals being found together with the jadeite at Tawmaw. The change would be represented chemically as follows:—

$$NaAlSiO_4 \text{ (Nepheline)} + NaAlSi_3O_8 \text{ (Albite)} = 2\ NaAlSi_2O_6 (2 \text{ Jadeite}).$$

Under certain conditions of crystallization nepheline-albite rock might form, while under conditions of high pressure during consolidation or after, jadeite, which has a much lower molecular volume, would be produced, the residual molecule forming albite or nepheline according to which molecule was in excess in the original magma. In the neighbourhood of Tawmaw occur various crystalline schists which are

[1] *Amer. Journ. Sci.*, 4th Ser., XVIII, 448–451.

intruded into by granite. The granite is traversed by veins of aplite and pegmatite (products probably of the same great eruption) and masses of crystalline limestone are found associated with the granitic rocks, containing various minerals characteristic of contact-metamorphism. The relations of the granite to the crystalline limestone in this region are similar to those of Mandalay Hill, Sagyin, and Mogok in the Ruby Mines district, where similar contact minerals, including the different varieties of corundum, are found in the metamorphosed limestone. The crystalline schists include chloritic schists with well-formed crystals of magnetite, actinolite schists and glaucophane schists. These are all regarded by Dr. Bleeck as the metamorphic products of basic igneous rocks affected by the adjoining granitic intrusions. The serpentines form a long narrow ridge, flanked on one or both sides by saussuritic-gabbros, saussuritic glaucophane-schists and chloritic schists. These rocks are traversed by granite and veins of quartz: all the rocks are regarded as genetically related, and as the results of the differentiation of the same magma, which gave rise successively to the peridotites, gabbros, nepheline-albite (jadeite) rock and the siliceous end-products of granite and quartz.

Relation to Tertiary Sediments.

In addition to the crystalline and igneous rocks there are exposures in this area of a sedimentary series, consisting of sandstones and conglomerates, with shaly layers and thin coal-seams. These beds were regarded by Dr. F. Noetling,[1] as miocene in age, and, although no fossils of stratigraphical value were found, Dr. Bleeck accepts the formation as belonging to some stage of the Tertiary system; but he differs radically from Dr. Noetling's views as to the relative ages of this sedimentary series and the serpentine-jadeite complex. Dr. Noetling[2] stated that the Tertiary strata are pierced by the basic igneous rocks that include the jadeite veins; but Dr. Bleeck finds that the eruptives, including the jadeite, are prominently represented among the boulders in the Tertiary conglomerate, and thus must have become weathered to contribute to the Tertiary sediments. These conglomerates are worked at Hweka for the jadeite-boulders, which are also collected among the recent alluvial deposits of the Uru river near Mamon.

Rubies of Naniazeik.

Dr. Bleeck also took the opportunity, while in the Myitkyina district, of examining the ruby-bearing deposits near Naniazeik. In all essential respects the

[1] *Records Geol. Surv. Ind.*, XXVI, 1893, p. 28.

[2] *Loc. cit.*, p. 28.

occurrence resembles the well-known area of Mogok described by Professor J. W. Judd and Mr. C. Barrington Brown.

Rubies are found in the soil and alluvial accumulations around the village of Naniazeik as well as in the river-gravels on the eastern slopes of the mountain ranges between Naniazeik and Manwe. This mountain range is composed mainly of granite and crystalline limestone, the latter having obtained its crystalline characters probably as stated before, through the intrusion of the granite. The limestone contains various minerals as the result of contact-metamorphism—garnet, spinel, chondrodite, graphite, forsterite, and other accessories, besides the valuable rubies and sapphires. The contact of granite and marble, exposed on the road from Sikaw to Naniazeik, shows the granite to assume a pressure structure near the margin, and to contain large quantities of phlogopite, which is a prominent mineral also on the marble side of the contact. The marbles, when freshly broken, have the characteristic evil smell of many limestones charged with nitrogenous organic matter. The marble is thus probably the result of the metamorphism of an ordinary sedimentary limestone of chemico-organic origin, but no data are obtainable to determine its age. Dr. Bleeck's paper is published in *Records, Geol. Surv. Ind.*, Vol. XXXVI, Part 3.

Palæontology.

Lower Eocene Mollusca.

The Mollusca from the Ranikot stage (Lower Eocene) are being described by Messrs. Cossmann and Pissaro of Paris, and the first instalment of their elaborate work, describing about 100 species of cephalopods and gastropods, has been received and translated by Mr. Vredenburg for publication in the *Palæontologia Indica*. On receipt of the description of the lamellibranchs it will be possible to estimate the stratigraphical significance of this work.

Intertrappean fossils in the Cretaceous of Baluchistan.

Mr. Vredenburg has sorted the valuable collections of Upper Cretaceous fossils from Baluchistan, and, during the course of this work, has discovered that the well-known freshwater gastropod *Physa Prinsepii* Sow. so characteristic of the freshwater beds intercalated in the Deccan Traps, occurs in marine beds containing Upper Cretaceous

(Mæstrichtian) ammonites. An account of this occurrence has been published as a special paper in the *Records, Geol. Surv.* (Vol. XXXV, p. 114, see also *Records*, Vol. XXXVI, p. 178, foot-note). The specimens have been found in the collections from the Des Valley, as well as in those from Mazar Drik, and all the essential features of the species are unmistakably displayed. The shells, therefore, must belong to individuals that were carried out to sea from the land on which the Intertrappean beds were laid down. The associated marine fossils fix the age of the beds with reasonable precision as upper Mæstrichtian, and we have thus an important piece of evidence to fix the age of the great Deccan Trap eruptions more precisely than was possible before.

Nummulitic rocks of the Palana coal-field.

A small collection of fossils obtained by Mr. Jervis from the Palana coal-field in the Bikaner State, Rajputana, has enabled Mr. Vredenburg to show that the coal-bearing series in this area corresponds to the Laki series of Lutetian age. In reviewing the fragmentary evidence regarding other post-Gondwana coal-fields in India, Mr. Vredenburg concludes that in most cases there is a balance of evidence in favour of a Laki age; he points out that there are many doubtful features in the evidences adduced for the existence of Cretaceous and of post-Nummulitic coal. This point, if confirmed, will give a valuable horizon for stratigraphical work, especially in Assam and Burma, where there are so many isolated small coal-bearing basins.

Study of Ostrea multicostata, Deshayes.

Among the Palana fossils occur specimens of *Ostrea multicostata*, Deshayes, a species about which there has been considerable confusion in geological literature. Mr. Vredenburg, having examined the descriptions of this and other close-ribbed *Ostreæ*, comes to the following conclusions:—

(1) The previous citations of *O. multicostata* in India refer to the following six species: (*a*) *O. angulata*, J. de C. Sowerby (Upper Nari and Gaj); (*b*) *O. latimarginata*, Vredenburg (=*O. flabellula*, Lamk., according to Sowerby; Upper Gaj); (*c*) *O. cubitus*, Deshayes (Lower Nari); (*d*) *Gryphæa Esterhazyi*, von Pavay (age uncertain); (*e*) *Ostrea turkestanensis*, Romanowski. (Nari in the lower Zhob valley); (*f*) *Exogyra* sp. (probably Cretaceous).

(2) The specimen regarded as eocene and figured in 1883 by d'Archiac and Haime as *Ostrea multicostata*, Desh., var.,

again figured under the same name, but as a miocene form, in both editions of the Manual (1879 and 1893), regarded, by Mayer-Eymer, in 1871, as the type of eocene species *O. orientalis*, is an incomplete, and consequently unsatisfactory specimen of the Aquitanian species *O. angulata*, J. de C. Sowerby.

(3) The true *O. multicostata* occurs in India in the middle eocene, and characterises the same beds as in Egypt and Southern Europe.

(4) The other close-ribbed species of *Ostrea sensa stricto* in the Indian Tertiary, are (*a*) *O. Fraasi*, Mayer-Eymer (Lower Nari), (*b*) *O.* n. sp. related to *O. Fraasi* (uppermost Gaj), (*c*) *O. digitalina*, Eichwald, var. *Rholfsi*, Fuchs, (Hinglaj series in the beds with *O. Virleti*), (*d*) *O. promensis*, Noetling [Yenangyaung series with (*e*) *O. peguensis*, Noetl., probably identical with *O. Virleti*].

(5) The Burdigalian stage, whose existence in Asia had been ascertained only over a very limited area, is found to be widely distributed in India, and includes the greater part of the Hinglaj series in the Mekran, the Yenangyaung series in Burma, and possibly the Cuddalore series, and other Tertiary beds in the coastal regions of the Peninsula.

Cretaceous Foraminifera.

Mr. Vredenburg has examined the collections of *Orbitoides* from the Cretaceous beds. These are found to agree generically, and in some cases specifically, with the forms known in Europe, while their stratigraphical distribution follows the European sequence. The Indian localities of the specimens examined are the Mari hills, and the province of Jhalawan in Baluchistan, Western Sind, the Suleiman range, and the Coromandel coast; the specimens occurring amongst Mr. Hayden's collections from Tibet have also been examined. It is in Dr. Noetling's collections from the Mari hills that the zonal sequence has been established in greatest detail. Mr. Vredenburg has identified a number of the associated fossils from this series, constituting the principal basis of the correlation which he has adopted.

In a general way three horizons are recognised—a lower one characterised principally by *O. media*, a middle one with *O. socialis*, *O. Hollandi* and *Omphalocyclus macropora*, and an upper one with *O. minor*. The lower zone is regarded by Mr. Vredenburg as principally Campanian,

the two others as Mæstrichtian. *Orbitoides media* and *Omphalocyclus macropora* are the two commonest species, and neither of them is entirely restricted to the zones above mentioned, *Omphalocyclus macropora* descending into the lower zone, and *Orbitoides media* rising into the middle one, but in a general way, *Omphalocyclus* is the newer form, rising into a horizon never reached by *O. media*, and *vice versâ*.

Mr. Vredenburg has noticed that in all the Indian occurrences *Omphalocyclus macropora* is represented by both forms megaspheric and microspheric. The existence of the dimorphism has for the first time been established only quite lately (December 1907) by Professor A. Silvestri in his study of the specimens occurring both at Mæstricht and in the neighbourhood of Palermo.[1] The constitution of the megasphere in the specimens from Baluchistan is identical with that of the Maestricht specimens figured by Silvestri. It is suggested that the close resemblance between *Orbitoides socialis* and the genus *Lepidocyclina* may be a case of "convergence."

Correlation of Baluchistan and Coromandel Cretaceous.

The identification of the fairly numerous ammonites from the Mari Hills and Jhalawan has enabled Mr. Vredenburg to attempt a correlation of the Baluchistan beds with the Ariyalur of Southern India: both the Valudayur and Trigonoarca beds are regarded as the equivalents of the lower part only of the ammonite-bearing beds of Baluchistan, those which have generally been spoken of as the "Hemipneustes-beds," and include the bulk of the two lower *Orbitoides*-bearing zones. The uppermost ammonite-bearing zone of Baluchistan (of which the leading fossils are *Sphenodiscus Ubaghsi*, *Indoceras baluchistanense* and *Cardita subcomplanata*) does not appear to be represented by any fossiliferous beds in the type region of the Coromandel. It possibly corresponds with the unfossiliferous sands, which, in the Trichinopoly area, intervene between the fossiliferous Ariayalur and Niniyur beds; but the stratigraphy of the Niniyur series has not been investigated sufficiently closely to allow of a strict correlation, though it certainly corresponds, in part at least, with the uppermost Cretaceous beds of Baluchistan and Sind, the "Pab sandstones" or "*Cardita Beaumonti* beds". In Western Persia, in the districts of which the geology has been unravelled by de Morgan and by Douville,[2] the "Echinoid beds" of these authors correspond principally with the Hemipneustes-beds of Baluchistan, while the "Cerithium-beds" are mainly the equivalents of the zone of *Cardita subcomplanata*. Mr.

[1] *Atti della Pontifica Acc. N. Lincei*, LXI, pp. 17—26.

[2] *Mission scientifique en Perse : mollusques fossiles, 1904.*

Vredenburg has suggested that the latter zone, unknown in the Trichinopoly and Pondicherri areas, may be represented further north along the east coast by the fluvio-marine intertrappeans of Rajamahendri, several of whose leading fossils, such as *Cerithium Stoddardi*, *Irania fosiformis* and *Physa Prinsepii*, are among the characteristic forms of the zone of *Cardita subcomplanata* in Baluchistan and Persia.

In consequence of the definite reference to well-known horizons resulting from a study of the Baluchistan fossils, Mr. Vredenburg is of opinion that the term "Pathanian," introduced by Dr. Noetling, becomes unnecessary as it clashes with the long established name "Mæstrichtian" (or "Dordonian").

Cretaceous Pseudofucoids near Fort Munro.

Mr. Vredenburg has studied a number of interesting specimens collected in the Suleiman Range by Mr. H. J. Maynard, I.C.S., the Revd. Mr. Lee-Mayer, Major F. W. Pirrie and Captain F. C. Nicolas. Among these are various markings of the kind well known in the Flysch formations of Europe, and formerly ascribed with doubt to algæ, but now generally regarded as tracks and trails of marine animals. The specimens of this nature from the neighbourhood of Fort Munro were obtained in rocks that have been correlated with the Pab series of uppermost Cretaceous age in Jhalawan, Baluchistan. Some of the markings are of a kind that might be made by various kinds of animals, and thus they show a general sameness of character in rocks of various ages, from Cambrian and possibly pre-Cambrian times to the Miocene. Although these structures are consequently of no assistance in determining stratigraphical horizons, they are interesting because they characterise the so-called *Flysch* facies of formations in various periods, and the occurrence of similar structures in the Vindhyan sandstones of Peninsular India suggests that this peculiar formation has also originated *à la Flysch*; to this, perhaps, is due its mysterious barrenness from the palæontologist's point of view. Mr. Vredenburg's description of the material from Fort Munro is published in *Records, Geol. Surv. Ind.*, Vol. XXXVI, Part 4.

Napeng (Rhaetic) beds: Northern Shan States.

The collections made during the progress of the survey of the Northern Shan States by Messrs. La Touche and Datta from the Napeng shales have been examined and described by Miss Maud Healey, and the results will appear as a special Memoir in the *Palæontologia Indica* (New Series, Vol. II, *Mem.* No. 4). The work has presented

considerable difficulty, owing partly to the state of preservation of the fossils, which are almost without exception mere casts, and partly to the fact that the great majority of them are lamellibranchs, with no trace of the rich cephalopod or brachiopod fauna of the Himalayan Mesozoics. The stratigraphical position also of the beds, in which the fossils occur, could not be determined with accuracy, since they are found in isolated patches on the surface of the Shan Plateau, and their relations to the rocks both above and below are very obscure.

Although the general facies of the fauna seemed in the first instance to Messrs. La Touche and Datta to indicate a Mesozoic horizon for these fossils, the recognition of a *Conocardium* among them by Dr. Nœtling pointed to a much earlier position, and they were consequently at one time referred with much doubt to the Devonian period, especially as the stratigraphical evidence available seemed to point in that direction. Subsequently other interpretations were accepted for the fragmentary evidence obtainable.

The researches of Miss Healey have now placed it beyond doubt that the Napeng beds are Rhætic, since they contain numerous specimens of the characteristic Rhætic form *Pteria* (=*Avicula*) *contorta*, in addition to *Grammatodon Lycettii* and *Gervillia præcursor*, while many other specimens closely resemble Rhætic species. It is, however, a fact that the Palæozoic genera *Conocardium* and *Modiolopsis* are represented, in addition to *Palæoneilo*, which is also found in the Devonian shales of Wetwin.

Exotic Blocks of Malla Johar, Kumaon.

In the Central Himalayas of the Kumaon division the younger Mesozoic beds that form the complicated syncline of the Chitichun area are capped in places by massive limestone blocks which either appear to rest conformably on, or are embedded in, the soft Jurassic shales. They are partly of Palæozoic and partly of Lower Mesozoic age, and the anomalous position of these blocks above younger strata has given rise to a considerable amount of controversy. On account of the way in which they are weathered out as picturesque crags, rising in abrupt pinnacles above the younger rocks around, similar occurrences in the Carpathians and Alps have long been known as *Klippen*, and with reference to their origin, as *exotic blocks*.

The first comprehensive account of the geology of the Central Himalayas of Kumaon is due to the late C. L. Griesbach (*Mem.*,

Geol. Surv. Ind., XXIII). In a short paper referring to the preliminary results of a special expedition undertaken by himself, Professor C. Diener and Mr. C. S. Middlemiss in 1892, Mr. Griesbach referred specially to these exotic blocks (*Rec., Geol. Surv. Ind.*, XXVI, p. 22), and explained their occurrence by faulting. Professor C. Diener (*Mem., Geol. Surv. Ind.*, XXVIII, pp. 1—27) subsequently gave a general account of the fossils found during the 1892 expedition, and discussed more fully the origin of the exotic blocks, generally endorsing Griesbach's views. The late Dr. von Krafft extended the survey of the frontier district between Hundes and Malla Johar in 1900, and published a special memoir (*Mem., Geol. Surv. Ind.*, XXXII, Part III) on the exotic blocks, which, as remarked by Diener in his memoir on the "Cephalopoda of the Triassic limestone crags of Chitichun" (*Pal. Ind.*, XV, Vol. II, Pt. II, Chap. 3), he considered to differ from the "Klippen" of Europe in being intimately connected with igneous extrusions; but von Krafft admitted the difficulty of offering a satisfactory explanation of where the blocks had come from and how they had reached their present position.

Professor Diener has now completed a detailed description of the Upper Triassic and Liassic fossils obtained mainly by von Krafft, and has applied his results to the theories in existence regarding the origin of these remarkable phenomena. Professor Diener's results prove to be of most unusual interest. He confirms von Krafft's conclusion that the Permian and Triassic beds in the blocks belong to facies quite different to those of the beds of corresponding age found in the normal sections in this area: the former von Krafft termed the *Tibetan* and the latter the *Himalayan* Series. Professor Diener now notices that, in the carnic and liassic beds of the Tibetan series, there are remarkable agreements with their homotaxial equivalents in the Mediterranean region, the agreement being often lithological as well as faunistic. The fossils of Lower Triassic and Muschelkalk age in the exotic blocks show small affinities with the Alpine Trias, and more nearly resemble those of the Himalayan region; but there is still a certain lithological contrast. But the carnic fossils of the Tibetan series differ largely from those of the Himalayan series, and show very close affinities to the zones of *Trachyceras Aonoides* and *Tropites subbullatus* in the Eastern Alps. Among the liassic fossils of the Tibetan series Mediterranean affinities are still more marked, the identity of species being almost complete in some blocks; in fact, the difference between the liassic faunas of Wurtemberg or Eng-

land and the Alps is even more conspicuous than between the latter and the lower liassic fossils of the Tibetan series found in the exotic blocks. It is generally accepted that to the north of the main region of the Himalaya there existed a part of the ancient ocean, known as *Tethys,* which was in direct communication with the European area, and while local peculiarities existed in Triassic times sufficient to distinguish the assemblages of fossils of the Tibetan series from those of the Mediterranean region, the conditions in these widely separated parts of *Tethys* were almost obliterated in liassic times. It is assumed that the exotic blocks of Malla Johar were brought from somewhere further north in the Tibetan region; but we still are unable to identify the region, and this discovery by Professor Diener of the remarkable agreement between the "Tibetan" and Alpine carnic and liassic fossils adds considerably to the interest of the question. Professor Diener's memoir is now in the press and will be issued as Vol. 1, Part I, Series XV, of the *Palæontologia Indica.*

Cambrian fossils: Spiti.

The description of the Cambrian fossils collected in the Parahio and Pin valleys in Spiti during the years 1898-1901 has recently been received from Mr. F. R. Cowper Reed and is of very considerable interest. The fauna comprises ten genera of trilobites, five genera of brachiopods, one of pteropods (*Hyolithes*), one echinoderm (*Eocystites*) and one zoophyte (*Coscinocyathus*). The trilobites constitute by far the greatest proportion of the fauna, and embrace thirty-one species, of which almost all are new, only one being definitely identified with a hitherto described species; while three others are either identical with, or closely allied to, previously known forms. Next in importance come the brachiopods, of which there are 14 species, only ten being sufficiently well preserved for specific determination: of these ten species, six are new and four closely allied to, or identical with, North American forms.

In the Parahio valley, whence most of the specimens were obtained, six horizons have been recognised; and it is a remarkable fact that the fauna of each horizon is peculiar to it, no single species having been found in any two horizons. The lowest horizon is characterised by the presence of small brachiopods (*Lingulella* and *Billingsella*) and the remaining five by trilobites, of which two genera, *Ptychoparia* and *Olenus*, largely predominate; the latter genus is restricted to the uppermost horizon, whilst *Ptychoparia* is absent from this, but occurs in all the remaining four.

The only trilobite that has been definitely identified with a known species is *Redlichia Noetlingi* Redl., a single specimen of which was found in the Pin valley near Muth. It has not been found in the Parahio sections, and its position in the sequence is not completely established, but it is almost certainly not higher than that of the lowest horizon with *Billingsella* and *Lingulella*. The presence in Spiti of this well-known Salt Range species is of great interest, since it is the only form known to be common to these two areas. Its presence, however, leads Mr. Cowper Reed to conclude that the beds in the Pin valley, from which it was derived, are of uppermost Lower Cambrian age.

The remaining trilobites, with the exception of those found in the highest, or Olenus, horizon, as well as the brachiopods and other fossils, are remarkable for their dissimilarity to either Salt Range or European types. On the other hand, they show decided affinities to genera from the Middle Cambrian beds of Western North America; and Mr. Cowper Reed, therefore, regards them as of Middle Cambrian age, concluding that at that period Spiti formed a part of the North American province.

The highest horizon is especially characterised by the presence of the genus *Olenus* and the absence of *Ptychoparia*, and is regarded as of Upper Cambrian age.

The general conclusions arrived at by Mr. Cowper Reed, as expressed in his own words, are—

"(1) the main mass of the beds must be referred to the Middle Cambrian, and the palæontological affinities of the fossils in these beds are with the Rocky Mountain province of America;

"(2) the Lower Cambrian is probably represented in Spiti, and the sole species which it has yielded is identical with one occurring in the Eastern Salt Range;

"(3) the Upper Cambrian is found at the top of the Parahio sequence, and contains a small assemblage of fossils of indefinite affinities, but includes a member of the genus *Olenus*, thereby suggesting a connection with the northern European province."

These results have an important bearing on the classification adopted for the oldest Palæozoic systems of the Himalaya. In Spiti the trilobite beds are separated from the next overlying rock group by a marked unconformity, and the fact that the Upper Cambrian is represented by only the uppermost part of the trilobite beds leads to the inference that this system must either extend up into the overlying conglomerate and red

quartzite hitherto regarded as Ordovician, or that almost the whole of the Upper Cambrian was removed before the deposition of the latter formations. The apparent absence of this unconformity in the Garhwal and Kumaon Himalaya, and the presence below the red quartzite of a bed of limestone, regarded by Mr. Griesbach as of Ordovician age, points rather to the latter view as the correct one. The fossils from this limestone, which are now in Mr. Cowper Reed's hands, have not yet been critically examined, but it is hoped that they will enable us to define the upper limit of the Cambrian system of the Himalaya.

To find the lower limit of the system will be more difficult. The lowest known fossiliferous horizon in Spiti is that of *Redlichia Noetlingi*, which is presumably of uppermost Lower Cambrian age; consequently the rest of the system must be looked for in the underlying "red quartz shales," defined by Mr. Griesbach as the uppermost member of his Haimanta system. It seems hardly probable that the whole of the Haimanta system, which is many thousands of feet in thickness, is of Lower Cambrian age, and Mr. Cowper Reed's work thus confirms Mr. Griesbach's suggestion that his Haimantas include also pre-Cambrian beds.

Gondwana plants: Kashmir.

The problems connected with the plant-bearing beds underlying the Zewan stage of Kashmir are discussed fully in Mr. Hayden's paper on "the Stratigraphical Position of the Gangamopteris beds of Kashmir.[1]"

Professor A. C. Seward kindly examined the additional fossil plants collected by Mr. Hayden in 1906, and found that while the species previously recognised are generally repeated, the new material serves to confirm the previous provisional determination of a new species of *Psygmophyllum* and some imperfect remains of *Cordaites*.[2] The evidence of this new material does not affect Mr. Hayden's conclusion "that the *Gangamopteris* beds are not younger than Upper Carboniferous and may belong to the base of that sub-division, or even to the Middle Carboniferous."

A systematic survey of these beds is now being undertaken by Mr. C. S. Middlemiss, who will keep especially in view the important questions regarding the stratigraphical relationship of the plant-bearing series to the volcanic rocks below, and the apparently conformable

[1] *Rec., Geol. Surv. Ind.*, XXXVI, pp. 23—39, 1907.

[2] Prof. Seward's results are published in Part I of *Records, Geol. Surv. Ind.*, Vol. XXXVI.

passage of Permian into Triassic beds above. The discovery of further representatives of the Gondwana flora will also be of the greatest interest in determining the geological age of the Peninsular coal measures.

ECONOMIC ENQUIRIES.

Copper.

During the field season 1906-07 Mr. K. A. K. Hallowes continued his survey of the copper-bearing belt in the Singhbhum district, and the area was inspected during 1907-08 by Mr. L. L. Fermor. In consequence of the favourable results said to have been obtained in the past by prospecting operations on the area leased to the Rajdoha Company, observations were first directed with a view of finding a suitable site for diamond drilling, to be undertaken on the completion of the operations in progress in the Kharsawan Estate.

Mr. Hallowes reported two parallel outcrops of the copper-impregnated schists striking approximately N.W.—S.E. and showing at intervals from Matigara at the south-east end of the Rajdoha property to near Rajdoha on the north-west. The copper-bearing zones and the enclosing schists dip towards the N.E. at angles varying from about 52° to 35°, and sites were selected to the north of the outcrop for later determination of the lodes by drilling. A similar survey of the copper-bearing band was made in the Dhalbhum Estate and in Suraikela.

The diamond-drilling accomplished during the year included—

(*a*) Kodomdiha, north of Amda in the Kharsawan State: a hole to the depth of 1,093 feet. This hole was intended to test the persistence of the lode previously cut further south at a depth of 392—404 feet. At this place the lode was about 8 feet thick, and carrying 5·102 per cent. copper;[1] it was struck by the diamond drill further north at a depth of 1,069 feet, but was there found to carry only 1·825 per cent. copper for a thickness of about one foot.

(*b*) Regadih (Galudih), 5 miles west of Kodomdiha.

In this place a shallow hole was drilled to test the copper lodes that have been extensively quarried on the outcrop.

[1] Mr. Hallowes is responsible for this and the assay results quoted below.

Drilling was extended to a depth of 430 feet. Specks and stringers of copper pyrites were found at various depths from 131 feet to 294 feet; but there was nowhere a concentration of ore. The nearest approach to concentration was at a depth of 293 feet, where a portion of the core 13 inches long only gave 0·606 per cent. of copper.

(*c*) Landup (Nadup) near Kalimati in the Dhalbhum Estate. Drilling was continued to a depth of 465 feet, but the only concentration of ore was found at about 197—198 feet, where for a thickness of 14 inches the lode yielded 3·335 per cent. copper.

So far as they go these borings demonstrate a drawback that is a common failing among the ore-deposits in Peninsular India, namely, abundant material widely disseminated instead of concentrated in a way that would permit of economic exploitation. The diffused character of the ore accounts for the apparently extensive nature of the ancient workings that mark the outcrop. The conspicuous, highly-coloured carbonates probably occurred scattered over wide zones; but no one now knows how much copper was obtained from these quarrying operations, of which no historical record is preserved. Another feature shown by the diamond-drilling is the general constancy in dip of the copper-bearing bands; had there been more disturbance of the rocks, however, there might possibly have been developed the compensating feature of richer concentration.

The most favourable results obtained in 1907 were those at 392—404 feet in the Kodomdiha Drill-hole; but it is impossible to say without further work along the strike whether this is a mere local swelling of the lode or a fair representation of it in this locality. Similarly, the less favourable results elsewhere may give an unfair idea of the deposits tested: it will be the business of those who take up concessions to extend the Geological Survey work by further prospecting where, as at Kodomdiha, the expenditure of more money would be a reasonable venture.

Further borings are now in progress near Matigara and Laukisra, and the completion of these will finish the programme as far as the Geological Survey is concerned.

A large quantity of material has been collected and on the completion of the work in the Laboratory a full description of the lodes and associated rocks will be published.

Gold.

The small gold-field on the Namma, a tributary of the Salween some 50 miles east of Lashio, was visited by Messrs. LaTouche and Brown. An abortive attempt had been made during the previous year to recover the gold in this field by means of a steam dredger, but the character of the deposit was found to be unfitted for this method of exploitation. It consists of gravel and boulders imbedded in a stiff clay, hardened by the deposition of calcareous tufa derived from thick beds of limestone forming the sides of the valley, and not sufficiently loose to enable the buckets of the dredger to excavate it. Some form of hydraulic mining would seem to be more suitable and promising, as there is an abunbant supply of water (which could easily be obtained at high pressure) available on the spot.

The Namma, Northern Shan States.

The gold appears to have come from the ancient rocks forming the crest of the range on the north side of the valley, for the lower slopes on this side, and the whole of the southern side of the valley, are composed of limestone.

Manganese-ore.

Mr. L. L. Fermor was deputed to South India to inspect certain recently opened-up deposits of manganese-ore with a view of completing the data for his memoir on Indian manganese. The deposits examined included those of Sandur in the Bellary district, Chitaldrug, Kadur, Tumkur and Shimoga in Mysore, and various occurrences in the Belgaum district.

South India.

Most of the deposits in South India differ in an essential character from those of Nagpur and adjacent districts in the Central Provinces: in the latter area the ore-bodies now appear to be an integral part of the crystalline complex, although it is probable that they have attained their present character as bodies composed mainly of clean oxides by alteration of manganese-silicates, possibly through the agency of subterranean water of meteoric origin; in South India, however, as in parts of Jubbulpore, the ore-deposits are more superficial, and appear to be residual products from the surface alteration of the various lithological elements that constitute the Dharwar system of schists. The manganese-ores occur irregularly associated with litho-

marges, ochres and wads, sometimes taking the form of nodules and concretions, and sometimes of more extensive masses. The Kumsi deposit in the Shimoga district of Mysore is an exceptionally large example of such surface accumulations of ore; but most of them are of small depth and comparatively low in quality.

Sandur.

Enormous quantities of the so-called superficial kind of ore occur also in the Sandur State, where they were noticed long ago by R. Bruce Foote,[1] who also described the great syncline of Dharwar schists forming the Sandur hills. Mr. Fermor concludes that the manganese and associated iron-ores are formed as weather-products from hematitic schists and slates similar to those on which the ore-deposits now lie. In spite, however, of the fact that the ore-bodies must be described as superficial, there is no doubt that millions of tons are available on the Ramandrug plateau: it has yet to be proved that the ores of the Central Provinces will be more lasting than some of these so-called superficial deposits, for those that in the Central Provinces form a part of the crystalline complex probably pass down into silicates unsuitable for the requirements of the metallurgist. We have no idea as to the depths to which the pure oxides extend in any case. Like the so-called superficial deposits, many of these have obviously greater resources than will be affected by mining operations in the near future, and their owners are not at present sufficiently anxious about the distant future to share with Government the expense of testing their ore-bodies by diamond-drilling. Mr. Fermor's report on the occurrences in Sandur State has been sent to the General Sandur Mining Company, which has leased the principal deposits.

Inspection of Mines, Central Provinces.

Mr. Fermor was also deputed to the Central Provinces to make a second inspection of the manganese-ore quarries. The rapid development that followed the rise of prices in 1906, and the accessibility of the ore-bodies, have attracted a certain number of workers whose experience in the methods of mining hardly enable them to carry out the covenants made in their leases and licenses; it was partly in order to assist such workers with advice and criticism, partly to ensure development without unnecessary waste and destruction of the ore-bodies, that these informal inspections have been ordered.

[1] Geology of the Bellary District, *Mem., Geol. Surv. Ind.*, XXV, p. 194, 1895.

During his last tour Mr. Fermor inspected the following deposits:—

Chhindwara district:—

Gowari Warhona, Sitapar, Gaimukh, Lakhanwara and Kachi Dhana, all worked by the Indian Manganese Company, Limited.

Nagpur district:—

Kodegaon, worked by the Indian Manganese Company; Gumgaon and Lohdongri, worked by the Central Provinces Prospecting Syndicate; Kacharwahi and Mandri, worked by the Central India Mining Company.

Bhandara district:—

Miragpur, worked by the Central India Mining Company, Hatora and Chikla, worked by the Central Provinces Prospecting Syndicate.

During his work Mr. Fermor received, as before, the courteous assistance of the Managers, and his report has been submitted to the Central Provinces Administration for communication to the Companies concerned. The criticisms made indicate a general improvement in the system of operations, an improvement that is the natural outcome of prosperity and consequent ability to entertain more highly qualified Managers. The disadvantages due to open cast workings, that were developed in the initial stages, before the Companies were assured of success, are now being generally recognised, and work is being planned for underground mining. The recent fall in prices will naturally limit the operations in a large number of cases, but a reasonable rest after the feverish rush to meet the heavy demands for ore that prevailed last year will not be wholly disadvantageous to the industry.

Mining Association.

The formation of the Central Provinces Mining Association is an incident welcomed by all interested in the progress of the manganese-mining industry; the recently settled question of adjusting the royalty charges to meet the rapid and great variations in ore-values is but one of the many problems, bearing on the industry, in which a representative Association can assist the aims of Government to maintain conditions equitable to the mining community, as well as to the previously established interests of other tax-payers.

Petroleum.

Upper Burma.

With the assistance of Mr. G. de P. Cotter, Mr. E. H. Pascoe was deputed for a second season to Burma for the supervision and further examination of

the oil-fields. Besides reports to the Burma Government regarding the local regulations, the geological work included :

South Yenangyaung field.

(i) *An examination of the faulted area to the south of Beme village in the Yenangyaung Oil-field.*—Indications of faulting had been observed by Mr. Davies of the Burma Oil Co., and on examination Mr. Pascoe established a fault of some magnitude extending obliquely N.N.E. to S.S.W. across the outcrops of the various Miocene beds from close to the crest of the anticline for some distance into the Pliocene. Other adjacent faults —probably minor ones—render the elucidation of this area difficult in the extreme. Whether the large fault extends completely across the Miocene outcrop or ends in the numerous veins of mud which have honeycombed the crest-beds is a point which, it is hoped, will be cleared up by further work. There appears to be some connection between this faulting and the failure to find anything in appreciable quantities but gas south of Beme.

Minbu.

(ii) *A survey of the Minbu Hills on a scale of 8 inches to a mile.*—This anticline of Miocene and Pliocene beds is one of great interest from a scientific point of view. Slightly asymmetric, and sharply folded, it has been very extensively denuded and its deeper structure laid bare. There are many comparatively large faults, one of which appears to coincide with the line of mud-volcanoes near the town of Minbu. In several spots within the 20 demarcated square-mile blocks, boring for oil has been undertaken but with little success. Although there is certainly room for further testing, it is very improbable that any large or richly yielding oil-field will ever be established here. An account of this area will be published later on.

Wetchok.

(iii) *Examination of a recently discovered Miocene outcrop near Wetchok, east of Yenangyaung.*—Only the topmost beds of the Miocene are exposed here, and the fold is in the form of a gentle elliptic dome, the longer axis of which runs in the usual direction of Miocene anticlines in Burma, *viz.*, N.N.W. to S.S.E. There are several faults within the area, but the presence of a red alluvial deposit renders the tracing of them and estimation of their magnitude, matters of great difficulty. From the oil-winner's point of view the promising nature of the gentle fold is more or less nullified by the presence of faults, the small vertical depth of Miocene exposed, and

the distance of the area from what has been termed the "oil-belt." A paper on this area is to be published shortly.

(iv) *Commencement of a resurvey of the Yenangyaung Oil-field.*—Two beds of marine fossils belonging to separate horizons and a bed containing a new variety of *Batissa*, were discovered. Several small faults not indicated in Dr. Noetling's published map, were found round the margin of the field, and it is chiefly for the mapping of these and the investigation of their effect upon neighbouring wells that a second survey has been undertaken.

Yenangyaung.

Mr. Cotter assisted Mr. Pascoe in examining the Yenangyaung oil-field and the method of digging and drilling for oil. Afterwards he commenced work on the Yenangyat field, mapping the eastern and western boundaries of the Miocene outcrop north and south of block 67. The main features of interest here proved to be the narrowing of the Miocene outcrop (due apparently to sharper folding) and the number of ferruginous conglomerate bands on the western flank of the anticline. These bands contain both fossil-wood and selenite, in consequence of which difficulty was experienced in establishing a definite boundary between the Miocene and Pliocene. Mr. Cotter was enabled to confirm Mr. Grimes' and Mr. Pascoe's observations on the inversion of the anticlinal fold here.

Yenangyat.

Mr. Cotter paid a visit to the Singu oil-field and among other fossils found a new species of *Dendrophyllia*, which was also found by Mr. Pascoe at Minbu. This coral is described in a paper published in *Records, Geol. Surv. Ind.*, Vol. XXXVI, Part 3.

Singu.

Mr. Cotter also surveyed Taungtha Hill. This anticline of Miocene and Pliocene is saddle-shaped, the crest sinking in the centre between two crest-maxima. Dips are very steep, especially on the eastern flank, and the beds appear to be considerably disturbed and faulted. Owing to this and the distance of the area from the "oil-belt," prospecting would not be very promising. Details of this region are published in *Records, Geol. Surv. Ind.*, Vol. XXXVI, Part 3.

Taungtha.

Later he examined the Yenangyaung blocks around Tatkan, between Singu and Yenangyaung, and pronounced unfavourably upon this tract. He was unable to identify any well-defined anticline here, and agreed with Mr. Grimes in considering the beds to consist of nothing but Pliocene.

Tatkan.

Salt.

Rajputana.

Dr. W. A. K. Christie, the Chemist, has been engaged mainly in the examination of brines and river-waters from Rajputana. The investigations into the salt-resources of the Sambhar Lake described in the General Report of the Geological Survey for 1903-04 and 1905 left us in a state of uncertainty about (*a*) the balance of effect due to the artificial manufacture of pure salt and the annual additions of chloride and other sodium salts brought in by the rivers, (*b*) the origin of the large quantities of salt within the drainage basin. Arrangements have been made for the annual sampling of the lake-brine and of subterranean brine from various parts of the lake-bed. Samples of the inflowing "fresh" water during the monsoon are also being collected. It will require some years probably to demonstrate any change in the resources of the Lake due to the opposed agents of loss and gain; but it is hoped that the system now organised for annual sampling and the great precision adopted in analysis will, in a few years, afford data of the greatest value in gauging the prospects of the industry, as well as in estimating the age and nature of the processes by which Sambhar reached its present degree of salinity.

To account for the large quantities of salt in the many isolated basins in the Rajputana highlands, I have suggested the action of the strong south-west winds which blow into the desert region from the salt incrusted Rann of Cutch during the dry hot months that precede the monsoon rains in each year. These winds are very inconstant in velocity, but very constant in general direction, and all movements of sand and salt towards the north-east are positive, until the first fall of rain in June or July washes the accumulated salt-dust into the lowest part of each isolated rock-basin, forming the many small salt-lakes in the desert, where Sambhar, though the largest still above the sandy mantle, is but one of many. To test this theory Dr. Christie has designed an ingenious set of instruments for sampling the desert winds during the hot weather. His results will be awaited with interest, as it is obvious that reliable support of the theory must affect our notions generally regarding the salt-deposits of desert regions, which are in general regions of indraught during hot dry seasons, when the salt crystals can break up into the finest dust. As desert conditions are often so marked in the rocks that accompany the older rock-salt deposits, a theory of this kind, if estab-

lished, would also affect our notions regarding the origin of such deposits. But it is dangerous obviously to speculate on secondary issues while the theory itself is under trial.

Silver-Lead.

Bawdwin, Northern Shan States.

The ancient silver-lead mines of Bawdwin-gyi (Great Bawdwin in Tawng-peng, one of the lesser Shan States, were visited by Messrs. LaTouche and Brown, who studied respectively the geology and mineralogy of that interesting locality. These mines were worked by Chinese from Yunnan for a very long period until about 50 years ago, when they were deserted, and traces of their activity are everywhere apparent, notably in the numerous galleries driven into the hill-sides for the extraction of the ore, and in the enormous heaps of lead-slag which were thrown away after smelting out the portion of the lead containing the bulk of the silver. A Company has been formed for the purpose of exploiting these slags, and is now engaged in laying a steam tramway to the spot in order to bring the material to a convenient locality for smelting.

The ores occur in a zone of intense disturbance, caused by one or more great overthrust faults traversing the rocks, which are felspathic grits and rhyolitic tuffs, probably of Cambrian age. They consist for the most part of argentiferous galena and zinc-blende, with a small quantity of copper-pyrites in minute granules. The crushing and fissuring of the rocks has enabled water or vapours impregnated with mineral solutions to percolate through the mass, the metallic ores replacing by metasomatic action the felspar and other rock-forming minerals originally present. An account of the geology and mineralogy of the locality is now ready for publication.

Tin.

Mr. J. J. A. Page was deputed to make a survey of the tin-mining areas in the Mergui district, mainly with a view of assisting the Local Government in the administration of the industry. After a preliminary examination of the ground, and, after examining at headquarters the data collected during this tour, he made a preliminary report, and commenced a more detailed examination of the district.

The country is thickly covered with jungle and decomposition products which effectually conceal the rocks over great areas, while the

means of communication being still in a primitive condition, exploratory work was necessarily slow.

So far as the geological observations go, no facts were obtained to disturb the general views previously held regarding the structure of the country. The principal hill-ranges, with a N.—S. trend, are mainly composed of granite, with flanking hills cut-out largely of unfossiliferous schists, slates, sandstones and quartzites. The granites appear to be intrusive into the sedimentary rocks, and are exposed in a series of bosses that do not form a continuous outcrop. There appear to be more than one generation of granitic rocks, and they are traversed by quartz-porphyry dykes. The sedimentary rocks are provisionally referred to the so-called Mergui series, but it is impossible to determine their relationship to the adjoining Moulmein series, which includes Carboniferous limestone; hence their true geological age is not certainly known. Isolated patches of strata, probably Tertiary in age, are found resting unconformably on the highly inclined Mergui slates and quartzites. The coal-bearing occurrences of these rocks in the Tenasserim valley have been described already by Mr. P. N. Bose, under the local name of the Tendau group.[1]

The country is largely covered with laterite and recent alluvial deposits.

The only tin-ore worked is cassiterite, which is widely distributed throughout the district, and is invariably found near the granitic hills. The mineral is found under the following four conditions:—

(1) *As a constituent of decomposed pegmatite rich in tourmaline and muscovite, known locally as "Kra".*—This material is found at Yaungwa, at several points along the road to Inner Bôkpyin, at Yengan, Migyaungchaung, Manoron and Yamon. *Kra* was found in the hills east of Mawton, just north of the Tenasserim river; and, although no cassiterite was found here in the pegmatite, it was obtained in the superincumbent soil. Tin-bearing *kra* was also found south of Yaungwa on the new road to Karathuri, and in the Kyoukchychaung to the south of a large isolated hill of granite.

(2) *In massive quartz-segregations in and on the outskirts of granitic hills.*—Some of these segregations are several feet in thickness, and sometimes carry also wolfram, pyrite and chal-

[1] *Records, Geol. Surv. Ind.*, XXVI, p. 153, 1893.

copyrite. Examples: North Hill, Khow Maung (Centre Hill) and Peetolai in the neighbourhood of Maliwun.

(3) *In quartz veins and stringers in ground adjacent to decomposing pegmatite.*—In cases like that at Youngwa it is necessary to remove the matrix with the small stringers for the separation of the cassiterite.

(4) *Hill-side talus accumulations due to the disintegration of classes* (1), (2) *and* (3), extending to gravel deposits along the steam valleys and in alluvial flats. These form the deposits most generally worked by the Chinese and Siamese immigrants.

The following tin-mining localities were examined by Mr. Page:—

(1) *Maliwun area:* (*a*) Klong Bankwa (10° 14′; 98° 38′). Several small workings by Chinese. The only working apparently profitable yields 6 lbs. cassiterite per cubic yard of "dirt." (*b*) Klong Nam Sai (10° 16′; 98° 39′). Only one working, carried to a depth of 42 feet, where rich tin-bearing material is found, but the mine is hampered by the cost of dealing with a great overburden. (*c*) North Hill, Peetolai and Centre Hill, taken up by the Burma Development Company under mining lease. In this area stanniferous quartz segregations are being exploited. (*d*) Hassei Deng (10° 9′; 98° 37′) and (*e*) Klong Glama (10° 12′; 98° 39′). Old abandoned workings only.

(2) *Karanthuri area:* (*a*) Chaungtenaung (10° 53′; 98° 46′). Two workings in alluvium, yielding also small quantities of gold. (*b*) Chaungkapra (10° 55′; 98° 48′). Five workings in alluvium. (*c*) Karathuri (10° 56′; 98° 48′) 22 workings on the hill-sides and low ground.

(3) *Yaungwa to Bôkpyin:* (*a*) To Twe (11° 4′; 98° 46′). Two workings. Tin occurs also in the mangrove swamps below high-tide level. (*b*) Hangpru (11° 1′; 98° 50′). Three active workings, and others abandoned. (*c*) Yaungwa (11° 8′; 98° 52′) to Inner Bôkpyin (11° 14′; 98° 50′). Four native mining leases owned by Messrs. Kinloch and Eglington are being worked; fifteen native workings besides prospecting licenses granted to two European companies who have closed operations.

(4) *Bôkpyin to Yengan:* (*a*) Sadien (11° 23′; 98° 48′). Many abandoned old workings. (*b*) Migyaung chaung (11° 25′; 98° 47′). Workings in pegmatite and alluvium; the deposits are rich, but difficult to work on account of want of water. (*c*) Yengan

(11° 27′; 98° 48′). Seven workings in good alluvium, hampered by want of water. The alluvial flats would be worth testing by borings with a view of pond-dredging from the adjoining creek.

(5) *Manoron area:* Keh chaung and Hesamkong (11° 31′; 99° 12′). Eighteen apparently profitable workings operated only in the rainy season. Stanniferous quartz stringers in one working only, the remainder being alluvial.

(6) *Mergui area:* Yamon (12° 13′; 98° 47′) to Naukle (12° 18′; 98° 47′). Eight workings, all shallow, yielding cassiterite from ½ to 2 lbs. per cubic yard of the stanniferous layer, which varies from 18 inches to 3 feet in thickness. The locality is possibly worth prospecting with a view of dredging.

(7) *Great Tenasserim Valley:* (*a*) Tagu (12° 16′; 99° 4′). One lease being worked besides abandoned old workings. Wolfram in white quartz fragments found with the alluvial tin, but not found *in situ*. (*b*) Theindaw (Tendau) (12° 20′; 99° 10′). Many old workings showing "pay-dirt" at a depth of about 16 feet. Concessions have been granted for working on European lines.

(8) Thabalik (12° 1′; 99° 15′) near the Siamese boundary. Five native leases being worked. The "pay-dirt" appears to be richer than in most places. In the streams wolfram was found in quartz fragments.

Tungsten.

While prospecting for manganese-ore in the Nagpur district Mr. J. Kellerschon, Agent in India for the Carnegie Steel Company, came upon a vein of mineral that proved to be wolfram on determination by Mr. G. G. Narke, a student-apprentice on the Geological Survey. Mr. Fermor was accordingly requested to examine the occurrence during the course of his annual inspection of the manganese-mines in December 1907. Meanwhile, the occurrence was developed by Mr. Kellerschon, to whom we are indebted for more material and full facilities for studying the deposits. According to Mr. Fermor's description, the deposit as exposed lies within the boundaries of Agargaon in the Umrer tahsil, where the wolfram is found as a constituent of quartz-veins intercalated in mica-schists and tourmaline-schists that belong to the Dharwar system. The wolfram-bearing veins are more intimately

connected with the tourmaline-schists, and the formation of the tourmaline was probably due to the same mineralising agencies which gave rise to the deposition of the wolfram and quartz in fissures opened along the foliation-planes of the schists.

The wolfram is irregular in its degree of concentration, and work had not proceeded far enough at the time of Mr. Fermor's visit to settle with certainty the economic prospects of the deposit. Crystals of the wolfram generally vary from ½ to 2 inches in diameter, but some of them measure as much as 4 to 5 inches across. The quartz-wolfram veins are of all sizes, from thin "stringers" to about 18 inches thick, and they permeate a band of "country" that may be 70 feet wide. The schists and included veins strike about W.S.W.—E.N.E., and prospecting licenses have been granted for the extensions in both directions from the original locality in Agargaon. Nothing was found at the surface to indicate this occurrence, and the chance discovery in a prospecting pit, put down because of some black stains supposed to be manganese-ore, gives an idea of how much is hidden in Peninsular India under the monotonous peneplain, in which the rocks are masked by a thin envelope of soil.

Water.

Ajmer.

Owing to the considerable growth of the city of Ajmer, whose prosperity within recent years has been greatly increased by the presence of the Railway workshops, the question of increasing the water-supply has become imperative, as, owing to the increase in the demand, the amount of water supplied by the present scheme threatens to fall short in years of drought. Owing to the elevated situation of the city, there is no hope of being able to furnish the supply by gravitation alone, and Mr. Vredenburg, who was deputed in April 1907, to report on this question, deprecates any scheme relying solely upon artificial or natural lakes, where the evaporation is great and the supply depends largely upon a rather precarious rainfall. The streams are all liable to dry up entirely during part of the year, and Mr. Vredenburg is of opinion that a sufficient supply should be obtainable by sinking large percolation wells through the thick alluvial formation that occupies the neighbouring valley. The fact that wells of this sort suffice to irrigate an area of several square miles in the neighbourhood of the town, even during years of greatest scarcity, is an indication that the

supply must be ample for the needs of the city. For the practical utility of any scheme it is important that the sources of supply be not too much scattered. Experiments are therefore being conducted in the hope of finding some convenient spot from which the whole supply or a considerable fraction of it might be obtained.

Mr. Vredenburg examined a number of wells within a radius of about 12 miles from the city, and came to the conclusion that the valley of the Sagarmati, south of the town, and that of the Sarsuti, west of it, appear the most promising areas, the first-named benefiting by a large drainage area. The wells are now being systematically tested, and experimental borings are also being sunk through the alluvium.

From one of these borings, put down in the month of June 1907 by Mr. Goodwin, in the Sarsuti valley, the water rose above the surface, and has continued flowing ever since, indicating the existence of artesian conditions, and thus reproducing on a small scale those observed in Baluchistan. There is a gentle slope of the alluvial formation from the hill-range bordering the Sarsuti valley on its eastern side, down to the river bed; the alluvial formation includes alternating layers of clay and of sand, the latter being blown sand re-distributed by rain, and it is this alternation of pervious and impermeable strata, combined with the slope of the ground, which accounts for the artesian conditions observed.

The hill ranges and the rocks underlying the alluvium belong to the Aravalli system of ancient schists, which are impervious, or in which water occurs only in fissures that cannot be systematically explored.

Gujarat.

The work of undertaking borings for water in Gujarat [Programme for 1906-07 (*i*)] could not be commenced until the completion of the boring operations in Singbhum. This work has, however, now been commenced by the Bombay Government acting with the advice of the Geological Survey.

Mineral Production.

The statistics of mineral production for the year 1907 have been published in a separate paper in the *Records, Geol. Surv. of India*, (Vol. XXXVII, pp. 57—128). The total value of the minerals, for which fairly reliable returns have been obtained, amounts to a little over seven millions sterling, being an increase on the total for 1906 of 12 per cent. The principal increases in value have been due to coal, petroleum and manganese ore. For the first time the value of the coal produced (reckoned as its sale price at the pitmouth), has exceeded the total

value of gold. The total quantity of coal raised during 1907 amounted to over eleven million tons, 96 per cent. having been obtained from mines in the Gondwana coal-fields of Peninsular India. The Jherria field alone produced over 46 per cent. of the total. Besides the generally satisfactory improvement in production, there has been a remarkably increased activity in prospecting; returns are not available for the licenses and leases that have been obtained by Companies in Native States and in other areas where the mineral rights have been alienated with the surface rights; but, in lands in which Government have reserved the mineral rights, there has been an increase in the number of concessions granted from 252 in 1906 to 600 in 1907.

REPORT ON GEOGRAPHY AND GEODESY.

BY

COLONEL S. G. BURRARD, R.E., F.R.S.

Dr. Stein's explorations in Turkistan.

Dr. M. A. Stein started from India in the spring of 1906, and after an absence of two and a half years he has now set out upon his return journey. During this long interval he has been continuing his geographical and archæological explorations in Chinese Turkistan, his former travels over this desert country having yielded results of great and unexpected value.

The Chiragh Tar Gorge.—On leaving Tashkurgan for Kashgar in June 1906, Dr. Stein detached Rai Sahib Ram Singh, Survey of India, to follow the Chiragh Tar Gorge. This gorge has been cut through the great Kashgar range by the Tashkurgan river, and Rai Sahib Ram Singh is the first geographical explorer who has passed through it. In places the walls of the gorge are perpendicular, and the only method of progress for the traveller is to climb the sheer face of the rock by means of the wooden stakes which have been driven by natives into the wall 100 feet above the torrent. Ram Singh crawled along these stakes for miles, and being unaccustomed to such surroundings he took the precaution to tie himself by ropes to his guides. Subsequently he joined Dr. Stein at Yangi Hissar.

The Hindu Tash pass.—In July 1906, Dr. Stein directed Ram Singh to visit Shahidulla and to cross the Kuen Lun range by the Hindu

Tash pass. Ram Singh decided to penetrate the Kuen Lun by the gorge of the Karakash river, but after following the river for some days he found that its channel became so narrow, and its stream so deep and strong, that his further passage was barred. His guide attempting to cross the river on a yak was swept away, and his khalasee, Jashwant Singh, riding a pony, met with the same fate : neither of the men was drowned, but Ram Singh decided to retrace his steps and select an easier route. After visiting Shaidulla, Ram Singh set out for the Hindu Tash pass. This he succeeded in crossing, and on reaching the first village on the further side he found the villagers filled with astonishment to see him and wondering where he could have come from, as no natives cross over the Hindu Tash now-a-days. Ram Singh describes the pass as only 17,000 feet high and as being buried under glacier ice. He was told by the villagers that in ancient times this pass was the main trade route between India and Chinese Turkistan, but that within the last century heavy falls of snow on the surrounding mountains have created a glacier intersected by crevasses and impassable for baggage animals.

Dr. Stein's movements.—No complete account of Dr. Stein's own exploration will be available until he arrives in India. It is known that during the winter of 1906-07 he was carrying out archæological explorations in the plains round Anshi and Tunhuang, and that in the summer of 1907 he was making geographical surveys of the outer and central ranges of the Nan Shan. In the autumn of 1907 he returned to his archæological investigations in the deserts of Tarim.

In the spring of 1908, he was excavating sand-buried towns in the Khotan and Keriya districts and was fixing their sites on his map.

Dr. Stein has discovered that the low and apparently insignificant hill range of Mazar Tagh, which flanks the Khotan river in the desert, is possessed of considerable length, and is continued throughout the western parts of the Taklamakan desert and beyond the Yarkand river far away to the north-west. The presence of a long continuous range stretching across the sandy floor of the Tarim basin is an interesting geological fact.

In April 1908, Dr. Stein crossed the Tarim desert from Khotan to Aksu, and it is hoped that during this journey he was able to lay down the hitherto disputed course of the Khotan river up to its junction with the Tarim; on leaving Aksu Dr. Stein penetrated the Tianshan mountains to the north.

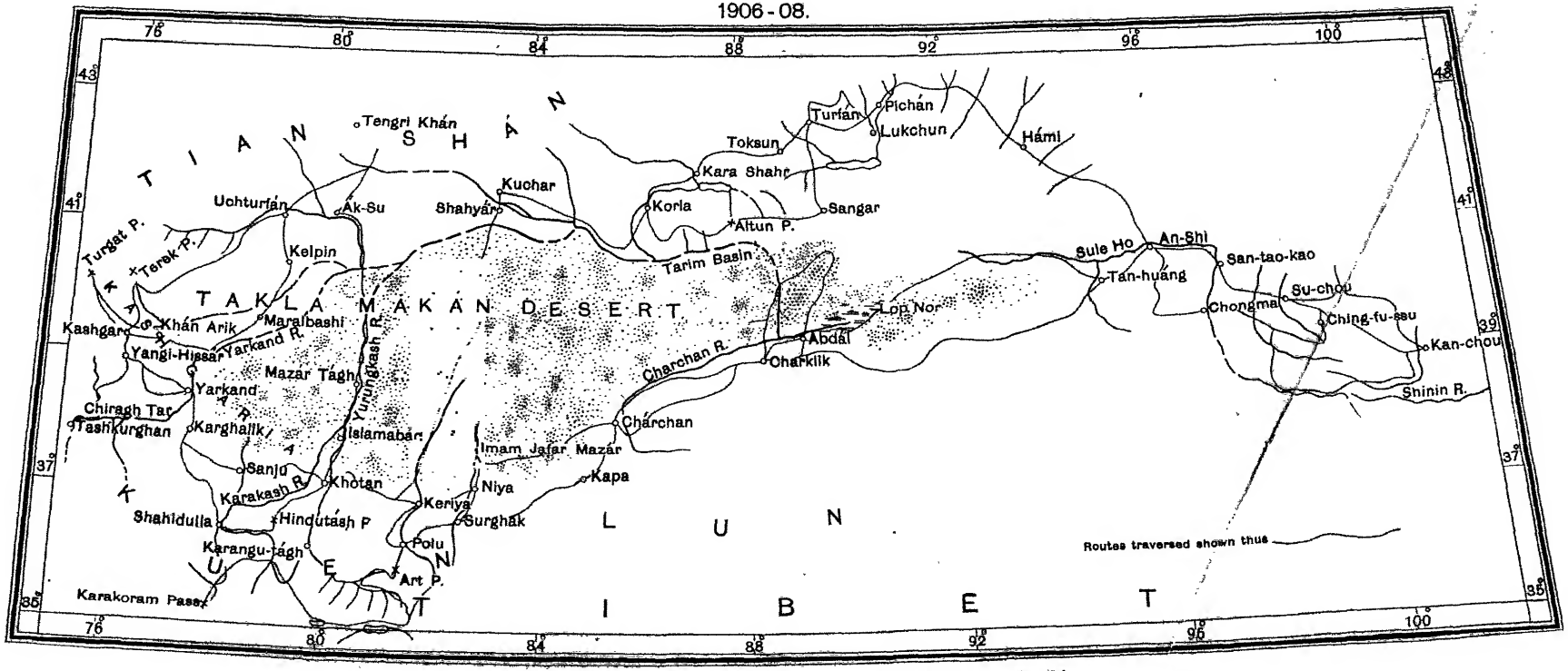
EXPLORATIONS IN CHINESE TURKISTAN & KANSU

BY

Dr. M. A. STEIN AND SURVEYORS RAM SINGH & LAL SINGH

in

1906 - 08.



Heliozincographed at the Office of the Trigonometrical Branch, Survey of India, Dehra Dún.

January 1909.

The length of the Indian Survey Standard.

In view of the possible employment in the near future of a four-metre Invar Standard and of Jäderin wires in the measurement of geodetic bases in India, it was deemed advisable that the Indian Standard Bar A, in terms of which the lengths of all the former Indian bases have been determined, should be sent to Europe to be compared against the new International Metre, so that we should have the means of referring bases of the future to those of the past.

In order to provide ourselves with data, which would enable us to detect any change of length, which might occur during the Bar's journey to Europe and back, rigorous comparisons were made between the standard Bar A and the two Secondary Standards I_b and I_s before the despatch of Bar A to Sevres. These comparisons were carried out at Dehra Dun between November 1907 and January 1908.

The precise object of the observations was the determination of the differences between the lengths of the Bars at a temperature of 62° F. The time available being too short to allow of a satisfactory re-determination of the co-efficients of expansions, it was decided to accept the co-efficients as determined in 1870, and in order to minimise the effects of errors in the adopted values of these co-efficients, the observers arranged that the mean temperature of the bars during the observations should be approximately 62° F. Some weeks before the commencement of the actual comparisons the room in which they were to be made was covered by a protection of thatch, an air space of 4 feet being left between the walls of the room and the enclosing thatch. By the aid of small stoves the temperature of the room was then satisfactorily controlled. Daily thermograph diagrams showed that, when communication with the outer air was stopped, the interior temperature seldom varied as much as one degree in 24 hours.

Bar A was compared against Bar I_s and I_b alternately. The two bars selected for comparison were laid in double walled boxes, thickly covered with wool and felt, and placed side by side on the traveller of the comparator. Each Bar was provided with two thermometers, the bulbs of which were placed in wells in the bar, filled with mercury in the case of the bars A and I_s and with oil in the case of bar I_b.

Forty-two sets of comparisons were made between Bars A and I_s, the temperatures of observation ranging from 6°·88 above to 5°·37 below 62° F. Thirty-eight sets of comparisons were made between Bars A and I_b, the temperatures ranging from 7°·13 above to 6°·34 below 62° F.

The results of the comparisons were:—

I_s—A at 62°F.=83·12 millionths of a yard.

I_b—A at 62°F.=196·73 millionths of a yard.

The comparisons made in 1867 and 1870 gave—

I_b—A at 62°F.=82·52 millionths of a yard.

I_b—A at 62°F.=213·98 millionths of a yard.

The difference between the old and the new comparisons of I_s—A is thus 0·60 millionth of a yard; this quantity is equal to the six millionth part of the length of Bar A.

The difference between the old and new comparisons of I_b—A is 17·25 millionths of a yard; this quantity is equal to the two hundred thousandth part of the length of Bar A.

On the conclusion of the comparisons at Dehra, Bar A was sent to Sevres for comparison with the International Metre. The results of the observations in France have now been received from M. Guillaume.

The length of Bar A at 62°F. has been found to be 3047·996 millimetres.

From Colonel Clarke's observations made in 1864, the length of Bar A at 62°F. was found to be 3047·984 mm.

The difference between the old and new values of length is thus—

0·012 mm.

or about 13·12 millionths of a yard.

The observations taken both at Dehra Dun and at Sevres increase our confidence in the Indian Standards of length. The comparisons at Sevres show that no sensible change can be detected in the length of the Standard Bar A, and the comparisons at Dehra Dun indicate no changes in the bars I_s and I_b relative to Bar A. Standard Bar A was brought to India in 1830 and the bars I_s and I_b in 1866: within the last twenty years great improvements have been made in the construction of standards of length, and greater accuracy of comparison is attainable with modern than with ancient standards. If the comparative coarseness of the old marks, which define the terminals of the Indian standards, is taken into consideration, no closer agreements can be looked for than those which have been obtained in the recent comparisons.

On the measurement of Geodetic bases.

Many years have elapsed since a base-line was measured in India, and during this interval a complete revolution in the method of precise linear measurement has taken place. That India has not been able

to keep pace with other countries has been due to the lack of personnel for carrying out geodetic measurements. In the United States of America base-lines are being measured at every 100 miles, and in South Africa they have been measured at intervals of 120 miles. Over the plains of Russia there has been an extraordinary development of the use of wires for linear measurements. In India proper there are sufficient base-line measurements, but throughout the whole of the Burma triangulation there is not a single base-line. During the last few years the Indian triangulation has been extended to the west through Baluchistan up to the Persian frontier but here again no bases have been measured.

It was therefore very desirable that information should be obtained as to the latest method of measuring geodetic bases, and for this purpose Captain Turner when in England was deputed to report on the use of Invar.

His report, which was received early in 1907, recommended that Invar wires of the type manufactured in Paris and tested by the Bureau International des Poids et Mesures at Sevres should be used. As these wires were being manufactured in 24 metre lengths, he recommended that the unit of measurement for geodetic surveys in India should be altered from the foot to the metre.

Captain Turner's recommendations have now been approved and a complete measuring apparatus, similar to that used by M. Guillaume, has been ordered from M. Carpentier of Paris. The wires will be standardised and tested at the Bureau International, and M. Guillaume has kindly undertaken to inspect the apparatus before it is despatched to India.

Principal Triangulation.

During the year three detachments were employed upon principal triangulation, and consequently a larger addition than usual has been made to the Geodetic Survey of India.

Western Baluchistan.—In Western Baluchistan Captain Browne completed the Kalat Longitudinal Series up to the Persian border; the new triangulation was 107 miles in length and contained 13 triangles with an average triangular error of 0″·35.

The Kalat series which has now been finished is approximately 480 miles long from its origin on the Indus to its terminus near Persia, and it embraces an area of 11,000 square miles within its triangles.

It is of interest to compare the accuracy of this Kalat Series, which is the latest triangulation of the Trigonometrical Survey of India, with the most recent geodetic work of other countries; the relative accuracies of different surveys may be compared by means of their respective probable errors, the smaller the probable error the greater the accuracy of the survey.

If in any triangulation N be the number of triangles, and $\Sigma\Delta^2$ the sum of the squares of the triangular errors, and if E be the probable error of an observed angle, then $E = \frac{2}{3}\sqrt{\frac{\Sigma\Delta^2}{3N}}$

This formula gives for the Kalat Series

$$E = 0''{\cdot}21$$

In the recent geodetic triangulation of Rhodesia

E was $0.''44$

In the triangulation of Cape Colony E was $0''{\cdot}34$, and in the triangulation on the 98th meridian of the United States of America E was $0''{\cdot}48$.

When we consider the great difficulties of carrying triangulation through an uninhabited and waterless country like Baluchistan and the hardships, to which the parties are exposed, marching as they have to do over low-lying burning deserts and then encamping on the highest peaks amid unceasing winds, we realise the determination and perseverance, that have been necessary in order to obtain results surpassing in accuracy the best work of Africa and America.

The Kalat series has taken four years to complete, the observers being Captain H. H. Turner, R. E. and Captain C. M. Browne, D.S.O., R.E.; of the 51 triangles only three have an error exceeding $1''$, and no triangular error is as large as $1''{\cdot}5$.

Five Astronomical Azimuths have been observed at different points of the series; and, if we compare the astronomical values with the values computed from the triangulation, the latter are always found to be too large. The persistency of the excess is a warning to us that our computations are taking the triangulation too far to the south. The error of direction is being gradually accumulated as we get further from the centre of India, because our formulæ for triangulation are derived from a spheroid, which is appreciably smaller than the true Figure of the Earth.

Koh-i-Malik Siah.—The westernmost station of the Kalat series is Koh-i-Malik Siah, the trijunction point of India, Persia and Afghanistan: this point is of interest both from its political importance and from its

being the most westerly limit now reached by the Principal Triangulation of India. The Astronomical Azimuth at this place differs from the value computed through the triangulation by 13″·04, the largest positive difference that has been discovered during the Indian observations. The value of latitude, hitherto accepted for Koh-i-Malik Siah, was found to be 1″·84 too great and the value of its longitude 4″·879 too great; the position on the earth, assigned to Koh-i-Malik Siah, was thus 468 feet in error.

Koh-i-Taftan.—An interesting mountain fixed with care from no less than 10 stations was Koh-i-Taftan. Its summit is formed by two main peaks of nearly equal height, the southern and higher being still an active volcano in more or less constant eruption.

Koh-i-Taftan is a very conspicuous landmark being visible on clear days from the whole country within 150 miles radius: no point within 300 miles of it approaches it in altitude, and it is covered with snow for nearly the whole year.

Its distance from the sea (about 250 miles) is, I think, the greatest of any active volcano in the world.

The co-ordinates of the two main peaks of Taftan are (*a*) south-west peak, (active volcano), Latitude 28° 36′ 0″·49, Longitude 61° 10′ 28″·14, height 12,973; (*b*) north-east peak, Latitude 28° 36′ 28″·63, Longitude 61° 9′ 54″·00, height 12,935.

The geographical positions hitherto assigned to the peaks of Taftan were found by Captain Browne to be in error by over 600 feet, the old positions being north-east of the true.

To the north-west of Taftan are several extinct volcanoes, and the whole region is a most curious mixture of aqueous and igneous deposits. The volcano of Koh-i-Sultan, on which Captain Browne observed for 10 days in 1907, is dying, but is not quite dead; though its huge crater is now floored with debris and silt, Captain Browne found his theodolite constantly disturbed by the tremors and pulsations of the mountain.

Burma.—In Burma the great Salween triangulation was re-started from the point, at which it had been discontinued in 1902-03: its direction has now been made to follow the British boundary so that it may encompass as much as possible of British territory.

Lieutenant Cardew, R.E., was the observer. He completed 14 triangles and extended the series by 55 miles; his average triangular error was 0″·64.

An Astronomical Azimuth was observed at Ḷoi Hpatan, and the difference found between the value so obtained and that computed from

the triangulation was 8″·01. The sign of this difference was negative, which is in accordance with other azimuthal observations in Burma, but which is directly opposed to the observations in Baluchistan.

The country through which the Salween series runs is wooded and mountainous, the stations being generally at an elevation of 7,000 feet.

By this extension into Eastern Burma combined with that into Western Baluchistan the length of the Indian arc of parallel has been increased to 38 degrees of Longitude.

Northern Baluchistan.—In Northern Baluchistan Lieutenant Oakes, R.E, has been at work throughout the hot weather on the new series of triangulation, which is to be carried from Kalat through Toba and Zhob along the Afghan boundary, and which will eventually join the Great Indus Series at Sheikh Budin.

During the coming winter Lieutenant Cardew will commence observations at Sheikh Budin, the eastern extremity of the series, and it is hoped that, with two observers working simultaneously, the whole series may be finished in 1909-10.

Tidal Operations.

During the past year tidal registrations by automatic tide-gauges have been taken at the ports of Aden, Karachi, Apollo Bander (Bombay), Prince's Dock (Bombay), Madras, Kidderpore, Rangoon and Port Blair.

The tidal observatory at Karachi, which was wrecked in the cyclone of June 6th, 1907, was re-started on October 12th, 1907, and has since been working satisfactorily.

The erection of the tidal cabin at Moulmein was completed in August 1908. The tide-gauge and other instruments will be installed before the end of this year, and registrations will be commenced on January 1st, 1909. Moulmein will now become one of the permanent tidal stations of Indian waters.

Levelling Operations.

The total outturn of double levelling during the field season of 1907-08 was 941 miles, in the course of which observations were taken at 12,094 stations. The Bench marks determined were 8 Standard, 70 Embedded, 667 Inscribed, and 25 belonging to other departments.

The old line of levels between Bombay and Madras, which was executed 30 years ago, had exhibited a closing error of 2·98 feet, Madras being placed 2·98 feet higher by this levelling from Bombay than it had

been shown to be by tidal observations taken in its own harbour. The 800 miles of levelling from Madras to Bombay have now been revised, and the new revisionary line has closed at Madras with an error of +0·607 foot.

The closing error has thus been reduced by 2·37 feet, from 2·98 to 0·607. General Walker, who was Surveyor General of India from 1879 to 1883, always maintained that the discrepancy of 2·98 feet at Madras was due to a steady and imperceptible accumulation of levelling error: the recent revision has shown that his view was entirely correct, and has disproved the theory that the mean sea level at Madras was actually lower than at Bombay.

The new pattern of level.—The levels, used by the Survey of India, have shown themselves trustworthy instruments, but they are of ancient pattern, and since they were made, undoubted improvements have been devised. At the International Geodetic Conference, which met at Copenhagen in 1905, the Superintendent of the Geodetic Survey of the United States of America exhibited a new pattern of level, which seemed to be a great advance upon all previous patterns. Two of these American levels were bought for the Survey of India, and were tried in the field last winter. The trials were entirely successful; and it will now be possible to work both more quickly and more accurately.

The device by which the *speed* of levelling can be increased is a very simple one: the telescope of the level is furnished with three intersecting wires instead of one. At each pointing of the level the staff can thus be read in three places simultaneously, instead of in one. This arrangement dispenses with the necessity both of chaining from the level to the staff, and of reading the *two* faces of the staff. We can now deduce the distance of the staff from the readings of the wires upon it; and the risk of reading the staff incorrectly to a *whole foot* is entirely eliminated by the triplication of the wires. It was merely to obviate this risk that staves were originally given two differently graduated faces. The operation of reversing the faces of the staves greatly prolongs observations, and is a troublesome step, that the levelling officers will gladly see dispensed with.

The plan by which the *accuracy* of levelling can be increased has been designed to get rid of the errors, that are caused by the observer walking round his level, when he wishes to read the bubble after observing with the telescope. When an observer transfers his weight from one side of a level to another, the ground sinks as he approaches and

recovers as he departs, and the bubble of the level responds to these disturbances. The observer is therefore always liable to read his bubble, when it is in a different position to what it was at the instant of his telescopic observation. In the American levels this liability to error has been eliminated: these levels are binoculars, and the two telescopes are viewed simultaneously; one telescope shows the image of the staff with the cross wires upon it, and the other telescope shows the image of the level bubble by reflection. It is easy now to watch both the staff and the bubble at the same instant.

As the instrumental improvements that have been introduced have proved successful, I have considered them to be worthy of mention in this report of progress.

Pendulum Operations.

The absolute value of gravity in India.—From the vibrations of a pendulum we are able to determine the *relative* intensity of gravity at the several places at which we observe, but the *absolute* intensity of gravity can only be deduced from the observations of a pendulum, if we know the latter's length. To measure the length of a pendulum from its bearing knife-edge to its centre of gravity, with any pretence to requisite accuracy, is an operation for which the trigonometrical survey has neither sufficient apparatus, nor suitable observatory. Enquiries have been received during the last year as to how we obtain our *absolute* values of g, and it is therefore desirable to explain.

Major Lenox-Conyngham observed the time of one vibration of each of his four pendulums both at Kew and at Dehra Dun: his results were as follows:—

Time of vibration (in seconds) of the mean pendulum.

October, 1903. At Kew, $0{\cdot}5067001 = S_1$

January, 1904. At Dehra Dun, $0{\cdot}5072524 = S_2$

Then if g be the required force of gravity at Dehra, and 981·200 c. m. be the absolute intensity at Kew;

$$g = 981{\cdot}200 \times \frac{S_1^2}{S_2^2} = 979{\cdot}062.$$

The first question, that may be raised is, what proof exists that the pendulums did not alter in length on their journey from Kew to Dehra Dun? The answer is that Professor Hecker brought independent pendulums from Potsdam to India in January 1905, and having compared them

against Major Lenox-Conyngham's he returned with them to Potsdam; his observations have confirmed those we had already obtained.

The second question, that may be raised is, on what basis does the assumed value rest of g for Kew, *viz.*, 981·200? This value is that adopted by Professor Helmert for the International Geodetic Association: it is not a final value, and will probably have to be modified at an early date. When any modification is introduced, a corresponding change in all the Indian values of g will become necessary.

Of more recent years Major Lenox-Conyngham has had reasons to fear that his pendulums might be changing in length: his results at Dehra Dun have been as follows:—

Date.	Time of vibration in seconds.	Value of g
January . .	1904	0·5072524	979·061
June . .	1904	
November .	1904	0·5072516	979·064
May . .	1905	
November .	1905	0·5072511	979·066
April . .	1906	
November .	1906	0·5072507	979·068
April . .	1907	

From January 1904 to April 1907, the change in the value of g has been persistent, and if this change is still found to continue during the next few years, it will have to be accepted as real. Hitherto the variation, though progressive in character, has been in the aggregate small, and it is still possible to hope that it has been due only to errors of observation.

Pendulum Observations in Southern India.—The work undertaken by No. 23 Party, Survey of India, during the early part of 1908, was the determination of the force of gravity at certain places in Southern India, with the object of ascertaining, whether the intensity would be found to be in defect in the montane and submontane tracts *in the south of Peninsular India* as has been discovered to be the case *in the Himalaya and Northern India.*

The stations visited were,

1. Mysore
2. Bangalore
3. Kolar, Edgar Shaft, surface
4. Kolar, Edgar Shaft, underground

} situated on the Mysore Plateau.

5. Ootacamand — On a summit of the Nilgiri Hills.
6. Yercaud — On a summit of the Shevaroy Hills.
7. Salem — At the foot of the Shevaroy Hills.
8. Kodaikanal — On a summit of the Palnei Hills.

The results of the season's work are given in Table I.

TABLE I.

Station.	Latitude.	Height above M. S. L.	Observed value of gravity = g	g reduced to sea-level = g_o	Theoretical value at sea level = γ_o	$g_o - \gamma_o$
	° ′ ″	Feet.	Dynes.	Dynes.	Dynes.	Dynes.
Mysore	12 18 52	2,501	978·045	978·191	978·236	—0·045
Bangalore	13 0 41	3,118	978·025	978·206	978·263	—0·057
Kolar, Edgar Shaft, surface.	12 55 47	2,945	978·076	978·247	978·260	—0·013
Kolar, Edgar Shaft, underground.	12 55 47	328	978·133	978·238	978·260	—0·022
Ootocamund	11 24 37	7,395	977·735	978·171	978·203	—0·032
Yercaud	11 46 56	4,493	977·908	978·180	978·217	—0·037
Salem	11 40 5	948	978·116	978·172	978·212	—0·040
Kodaikanal	10 13 50	7,665	977·643	978·092	978·164	—0·072

Table II is of interest as it shows that the defect of gravity at the stations of South India is considerably less than at places of similar altitudes in Northern India. At the stations, for example, of Ootacamund, Yercaud and Kodaikanal, both the actual deficiency of rock in the crust and the degree of compensation are notably less than at stations at similar heights in the Himalayan mass.

TABLE II.

Region.	Locale.	Stations.	Height.	$g_0 - \gamma_0$ = defect in g.	Corresponding thickness of rock in defect.	Mean deficiency of rock in the crust.
			Feet.	Dynes.	Feet.	
Montane	South India	Ootacamund	7,395	—0·032	910	For montane stations: deficiency in Northern India = 3,504 feet, deficiency in Southern India = 1,337 feet.
	...	Kodaikanal	7,665	—0·072	2,050	
	...	Yercaud	4,493	—0·037	1,050	
	Himalayan	Mussoorie, 1	6,924	—0·109	3,100	
	...	Mussoorie, 2	7,131	—0·115	3,270	
	...	Simla	7,043	—0·119	3,380	
	...	Darjeeling	6,966	—0·143	4,070	
	...	Kurseong	4,915	—0·130	3,700	
Plateau	South India	Kolar, surface	2,945	—0·013	370	For plateau stations: deficiency in Northern India = 3,595 feet, deficiency in Southern India = 1,090 feet.
	...	Bangalore	3,118	—0·057	1,620	
	...	Mysore	2,501	—0·045	1,280	
	Baluchistan	Quetta	5,520	—0·138	3,920	
	...	Mach	3,522	—0·115	3,270	

TABLE II—*contd.*

Region.	Locale.	Stations.	Height.	g_0-y_0= defect in g.	Corresponding thickness of rock in defect.	Mean deficiency of rock in the crust.
	South India	Salem	948	−0·0	1,140	
Sub-montane	Himalayan	Siliguri	387	−0·135	3,840	For submontane stations: deficiency in Northern India = 3,084 feet, deficiency in Southern India = 1,140 feet.
	...	Nojli	879	−0·096	2,730	
	...	Roorkee	868	−0·107	3,040	
	...	Dehra Dun	2,241	−0·121	3,440	
	...	Kalka	2,202	−0·084	2,370	

It will be noticed from Table I that Major Lenox-Conyngham observed his pendulums both at the top and at the bottom of the Edgar Shaft of the Champion Reefs mine: his two pendulum stations were in the same vertical line, and were separated by a vertical distance of 2,617 feet. Major Lenox-Conyngham's results furnish us with data, from which a value for the Mean Density of the Earth can be deduced, but we have so far not decided how to utilise the data. From similar observations in a Welsh coal mine Sir George Airy calculated the Mean Density of the Earth: he determined by direct measurements the absolute density of the rocks of the Earth's crust, situated between his upper and lower stations, and then from his pendulum observations he was able to calculate the ratio between the density of these surface rocks and the density of the Earth as a whole. But modern geodetic research has brought to light certain facts which show Sir George Airy's method to be unreliable: (firstly) he assumed that his measurements of the density of surface rocks gave him a value for the general surface density of the Earth, whereas the density of the Earth's surface has now been found to be different in different regions, (secondly) he omitted to take into account the extraordinary deficiencies and excesses of matter, that have been found to under-

lie many parts of the crust, at depths of from 30 to 70 miles, and that prevent us now from accepting any one locality as normal or typical.

Deflections of the Plumb Line.

Deflections of the plumb line were observed in the regions south and east of Deesa, where marked and sudden changes of density had been previously discovered in the earth's crust underlying flat desert tracts. It was hoped that we should be able to determine *the depth below the surface* at which the changes of density were occurring.

When the programme was designed, it was believed that the variations in gravity near Deesa were due to some *essentially local* cause, and that consequently an investigation of depth would be simpler here than in the Himalaya, where the area involved is so extensive. Captain Cowie's observations have, however, produced results that were not expected and it is now evident that the subterranean disturbing cause is more complex than had been supposed.

The following table shows Captain Cowie's results:—

TABLE III.

	Station.	Longitude.	Height above M. S. L.	Astronomical Latitude.	Geodetic Latitude.	Deflections of gravity.
			Feet.			
1	Tiki . .	73° 53′	2,369	24° 55′ 34″·52	24° 55′ 38″·24	—3″·72
2	Lakarwas .	73 52	2,574	24 31 41·05	24 31 47·99	—6·94
3	Morali .	73 0	466	23 25 17·47	23 25 23·18	—5·71
4	Kainath .	73 1	1,385	23 51 14·99	23 51 23·79	—8·80
5	Kardo .	72 46	807	23 57 2·17	23 57 10·02	—7·85
6	Dhamanva	72 33	397	23 32 2·66	23 32 8·40	—5·74

List of Publications of the Survey of India during 1907-08.

1. Account of the operations of the Great Trigonometrical Survey of India, vol. XVIII—*Astronomical Observations for Latitude made*

during the period 1885 to 1905, and the deduced values of the Deflections of the Plumb-line, Dehra Dun, 1906.

2. General Report on the Operations of the Survey of India during 1906-07, by Colonel F. B. Longe, R.E., Calcutta, 1908.

3. Report on the treatment and use of Invar in measuring Geodetic Bases, by Captain H. H. Turner, R.E., London, 1907.

4. A sketch of the Geography and Geology of the Himalayan Mountains and Tibet by Colonel Burrard and Mr. Hayden. Parts I, II, and III, Calcutta, 1907.

BOTANICAL SURVEY.

BY

W. W. SMITH, M.A.,

Acting Director, Botanical Survey of India.

Eastern India.—*Bengal.*—It was not found possible during the year to depute any European officer for survey work in Eastern India. The Superintendent, the only officer of the survey available, was too fully occupied with other duties and the Garden staff was too limited to permit of a subordinate officer being thus engaged. Several native collectors were employed in various localities, chiefly for seeds required in India and abroad. In the garden and in its immediate neighbourhood a beginning was made of a photographic survey of types of vegetation with very satisfactory results.

The usual collections of both plants and seeds were made in the Darjeeling District and in Sikkim; these were distributed chiefly to European and American Botanic Gardens and Herbaria. Mr. I. H. Burkill contributed to the Calcutta Herbarium a series of plants collected on the Singlela ridge. The Herbarium is also indebted to Captain F. H. Stewart, I.M.S., for a large collection of Tibetan plants from the neighbourhood of Gyantse.

Eastern Bengal and Assam.—Mr. A. Meebold visited various Districts on behalf of the Survey and obtained valuable collections from this area which are being incorporated into the Herbarium. From the neighbourhood of Manipur native collectors forwarded living specimens chiefly of Orchideæ.

Burma.—Mr. Meebold collected in various localities from Rangoon to Mandalay. Mr. I. H. Burkill added to the Herbarium valuable specimens from Arracan---a District hitherto poorly represented in our collections. Forest officers continue to send interesting specimens and native collectors forwarded Orchideæ from the Shan Hills.

Western India.—Mr. G. A. Gammie, Economic Botanist, has completed another part of his work on the Orchids of the Bombay Presidency and has written a note on the introduction of American Cottons in the Bombay Presidency, and a note on the Setarias.

Tours.—Mr. H. M. Chibber, Assistant Professor of Botany, toured through Kathiawar, Panch Mahals, Ahmedabad, Khandesh, Satara, and Belgaum districts. Messrs. R. K. Bhide, G. B. Patwardhan, and H. P. Paranjape, Assistants to the Economic Botanist, toured through Belgaum, Ratnagiri, Thana, Nasik, Ahmednagar and Poona Districts, the junior staff, Messrs. L. D. Garade, L. R. Khomne, S. R. Jogadeo and R. G. Jawlekar accompanying them.

A note on the flora of Thana is almost ready for publication. The specimens of the indigenous fodder grasses kindly supplied by the several District Officers of the Presidency have nearly all been identified together with the millets under cultivation and descriptions accompanied by drawings of them will shortly be published.

Southern India.—No special systematic survey was made owing to the absence of Dr. Barber in England. The subordinate staff collected in the Circars and in Tinnevelly and Madura Hills. Dr. Barber continued his studies in root parasitism and the results are published in the Botanical series of the Agricultural Memoirs. Mr. C. E. C. Fischer of the Forest Department forwarded to the Calcutta Herbarium collections made in North Coimbatore and North Malabar, in continuation of his previous systematic work in these districts. Mr. I. H. Burkill contributed a series of Deccan grasses. The South Indian flora is inadequately represented in the Calcutta Herbarium and additional contributions are very much desired.

North-West India.—From this area the Survey is indebted to the following for valuable contributions :—

Sir H. A. Deane, K.C.S.I., Chief Commissioner of the North-West Frontier Province, forwarded several collections from Peshawar and Afghanistan; Mr. I. H. Burkill, a series of Baluchistan plants, collected by the Gazetteer staff under the direction of Mr. R. Hughes Buller, I.C.S., and a collection from Simla; Colonel J. M. Carpendale, plants from

Kashmir; Mr. James Marten of the Forest Survey Department plants from Bannu; Mr. T. F. Main from Umballa; Mr. A. R. Tucker of the Department of Revenue and Agriculture, a further collection of North-West Himalayan plants.

The Botanical Survey suffers a severe loss in the death of Sir H. A. Deane, who for the last few years has been a constant contributor and correspondent, and has added much to our botanical knowledge of the Frontier Province.

General.—The list of publications at the end of this report sufficiently indicates the research work which comes within the scope of this review. Rev. Father E. Blatter, S.J., continues his studies on flowering season and climate, and Mr. Burkill his on the modes of pollination of certain Indian plants.

The Economic Botanists of the various provinces have, as in previous years, given as much time to Survey work as they could spare, but their own special duties are becoming more and more onerous and thus it is to be feared that in future the Survey will be unable to rely on their assistance. This reduces the actual staff on the Survey to one man—the Director—and emphasises the need of an adequate organisation and staff, if any progress whatever is to be made.

Publications.—Of the Records of the Botanical Survey there were published No. 3 of Vol. III (Professor L. Radlkofer's *Sapindaceæ novæ indicæ et malaicæ*), and No. 4 of Vol. III. (Professor C. deCandolle's *Revision of the Indo-Malayan species of Cedrela*). No. 5 of Vol. III, an index completing the volume, has also been published.

Another part of Dr. Cooke's *Flora of the Presidency of Bombay* has been issued bringing the work down to the beginning of *Araceæ*.

Of the two volumes of the Annals of the Royal Botanic Garden, Calcutta, Vol. VI, part II, Messrs. West's *Fresh water Algæ from Burma*, and Vol. XI, part I, Professor Beccari's *Monograph of the species of Calamus*, reported last year as still in the Press, the former has been issued and the latter is about to be issued. Parts 19 and 20 of Sir George King and Mr. J. S. Gamble's *Materials for a Flora of the Malayan Peninsula* were issued and bring the work to the end of *Plantagineæ*. The *Flora of Chittagong* by Mr. R. L. Heinig has been published and also a further note on the *Orchids of the Bombay Presidency* by Mr. G. A. Gammie, as already mentioned.

The other publications on Indian Botany published during the year are given in the list appended to this report.

A list of papers on the Botany of India published during 1907-08.

ANONYMOUS . Patchouli. (*Kew Bull., 1908, p. 78.*)

BARBER, C. A. . Parasitic trees in Southern India. (*Proc. Cambridge Philos. Soc., xiv, 3, pp. 246—256, with plates.*)

BARBER, C. A. . Studies in root parasitism. The Haustorium of *Santalum album*, part 2, the structure of the mature Haustorium and the inter-relations between host and parasite. (*Memo., Dept. Agri. India, i, 1, 2, pp. 1—58, with plates.*)

BARBER, C. A. . The Haustorium of Olax scandens. (*Memo. Dept. Agri. India, 1, No. 4.*)

BEDDOME, R. H. . Notes on Indian Ferns. (*Journ. Bom. Nat. Hist. Soc., xviii, 2, pp. 338—342, 1908.*)

BLATTER, E. . Contributions to the Flora of North Coimbatore. (*Journ. Bom. Nat. Hist. Soc., xviii, 2, pp. 390—429, 1907, with map.*)

BLATTER, E. . Acta et agenda by the Bombay Botanists. (*Journ. Bom. Nat. Hist Soc., xvii, 3, pp. 562—577, 1907.*)

BLATTER, E. . Cassia renigera Wall. (*Journ. Bom. Nat. His. Soc., xvii, 4, pp. 1036—1037, with plates, 1907.*)

BLATTER, E. . Flowering season and climate. Part II, 1907. (*Journ. Bom. Nat. His. Soc., xvii, 3, pp. 697—708, with plates.*)

BONATI, G. . Sur quelques espèces nouvelles du genre Pedicularis. (*Bull. Soc. Bot. France T. liv, pp. 371—377, June 1907.*)

BURKILL, I. H. . A note on Swertia tongluensis, and on a new variety of Swertia purpurascens. (*Journ. and Proc. Asiat. Soc., Bengal, iii, 1, p. 33, 1907.*)

BURKILL, I. H. . On Gentiana coronata Royle. (*Journ. and Proc. Asiat. Soc., Bengal, iii, 3, p. 149, with plates.*)

BURKILL, I. H., AND FINLOW, R. S. On three varieties of *Corchorus capsularis* Linn., which are eaten (*Journ. and Proc. Asiat. Soc., Bengal, iii, 10, 107, p. 633.*)

BURKILL, I. H. . Note on the Pollination of flowers in India. Note No. 4 on Cotton in Behar. (*Journ. Asiat. Soc., Bengal, iii, 7 July 1907.*)

BURKILL, I. H. . Anguillicarpus—a new genus of the Cruciferæ. (*Journ. and Proc. Asiat. Soc., Bengal, N. S., iii, 8, pp. 559—561, with plates, 1907.*)

BURKILL, I. H. . A variety of Ducrosia anethifolia Boiss, from Baluchistan. (*Journ. and Proc. Asiat. Soc., Bengal, N.S., iii, 8, pp. 563—564, 1907, with plates.*)

CANDOLLE, C. DE . A revision of the Indo-Malayan species of Cedrela. (*Rec. Bot. Surv. Ind., iii, pt. 4, 1908.*)

CLARKE, C. B. . Reductions of the Wallichian Herbarium, iii, Cyperaceæ. (*Kew Bull. 1907, 7, pp. 261—281.*)

COOKE, T. . The Flora of the Bombay Presidency, ii, pt. iv. Euphorbiaceæ to Araceæ, pp. 625—816.

COTTON, A. D. . New or little known marine algæ from the East. (*Kew Bull. 7, 1907, pp. 260—264, with plates.*)

DRUMMOND, J. R. . Literature of Furcræa with Synopsis of the known species. (*St. Louis Rep. Bot Gard., 1907, with plates.*)

ELLIS, E. V. . Cephalostachyum pergracile in flower. (*Indian Forester, xxxiii, 7, pp. 323—324, 1907.*)

ENERS, D. T. . The evergreen forests of the Maunjarabad Forest Range, Mysore State. (*Indian Forester, xxxiii, 7, pp. 324—328, 1907.*)

FISCHER, C. E. C. . Host plants of Loranthaceæ. (*Indian Forester, xxxiii, 8, pp. 353—355, 1907.*)

FISCHER, C. E. C. . Summary of genera and species described in the Flora of British India. (*Indian Forester, xxxiii, 8, pp. 355—362, 1907.*)

FISCHER, C. E. C. . A remarkable tree. (*Journ. Bom. Nat. His. Soc., xvii, 4, pp. 1027, 1907.*)

GAGE, A. T. . A case of lateral Floral Prolification of the inflorescence of the Pine-apple (Ananas sativus

Schult. f.) (*Journ Asiat. Soc., Bengal, Vol. iii, 9, Nov. 1907, p. 593.*)

GAGNEPAIN, F. Quelques Burmannia asiatiques nouveaux de l'Herbier du Museum. (*Bull. Soc. Bot. France liv, pp. 459—465, Juin 1907.*)

GAMMIE, G. A. . The Indian Cottons. (*Memo. Dept. Agri. India Bot. ser. ii, 2, 23, pp. 14, col. pl.*)

GAMMIE, G. A. . The orchids of the Bombay Presidency. (*Journ. Bomb. Nat. Hist. Soc., xviii, 1, Nov. 1907, pp. 88—91, with plates, and also part iv, Journ. Bom. Nat. His. Soc., xvii, 4, pp. 940—942, with plate, 1907.*)

GRAY, O. B. . The India Tulsi Plant (Ocimum sanctum). (*Pharm. Journ. lxxix, 1947, pp. 506—507, 1907.*)

HEINIG, R. L. . Flora of Chittagong.

HEMSLEY, W. B., AND WATSON, W. Saxifraga Brunoniana. (*Curtis Bot. Mag. 1908, 4, ser. 4, Nr. 40.*)

HILL, M. . Note on the introduction and acclimatization of the Mahogany (*Swietenia Mahogani*) in India. (*Indian Forester, xxxiii, 7, pp. 308—312, 1907.*)

KARSTEN, G. . Das indische Phytoplankton. (*Wiss. Ergebn. d. deutsch. Tiefsee Exp. a. d. Dampfer Valdivia, 1898-1899, Hrsg. v. C. chum. Bd. ii Tl. 2, Lfrg. 3, pp. 223—345, 20 Taf, 5bb. Jena, G. Fischer, 1907.*)

KING, SIR GEORGE, AND GAMBLE, J. S. Materials for a Flora of the Malayan Peninsula, Nos. 19 and 20. (*Journ. and Proc. Asiat. Soc., Bengal, lxxiv, pt. 2, pp. 383—728, 1908.*)

LUSHINGTON, A. W. . Note on some sucker-produced forests of the Krishna District, Madras. (*Indian Forester, xxxiii, 10, pp. 445—451, 1907.*)

PEITZER, E. UND KRANZLIN, F. Orchidaceæ-Monandræ-Cœlogyninæ. (*Das Pflanzenreich. Heft 32, p. 169, with plates, 1907.*)

PRAIN, D. . Diospyros Kaki, Linn. f. and Meconopsis (*Eumeconopsis*) bella, Prain. (*Curtis's Bot. Magazine, 4th ser., iii, 28, April 1907.*)

PRAIN, D. . Codonopsis convolvulacea. (*Bot. Magazine iv, 38, February 1908.*)

RADLKOFER, L. . Sapindaceæ novæ indicæ et malaicæ ex herbario calcuttensi. (*Rec. Bot. Surv. Ind. iii, pt. 3, 1907.*)

RAM, D. . Notes on the flowering, seeding, and cutting of Strobilanthes in Jaunsar Division in 1906. (*Indian Forester, xxxiii, 10, pp. 451-452, 1907.*)

TURNER, T. E. C. . Note on Terminalia Chebula and its fruit the Myrabolam of commerce. (*Indian Forester, xxxiii, pp. 362—365, 1907.*)

WILLIS, J. C. . The geographical distribution of the Dilleniaceæ, as illustrating the treatment of this subject on the theory of mutation. (*Ann. Roy. Bot. Gard. Peradeniya, iv, 2, pp. 69—77, 1907.*)

ECONOMIC BOTANY.

BY

ALBERT HOWARD, M.A. (CANTAB.), A.R.C.S. (LOND.), F.C.S., F.L.S.,
Imperial Economic Botanist.

Cotton.—The principal contributions during the year ending June 30th, 1908, to the Economic Botany of India deal with the improvement of cotton. The amount of attention now being bestowed on this crop by botanists offers a good example of the influence of practice on Science. It is perhaps safe to say that but for the recent efforts to develop cotton growing within the Empire none of the investigations indicated below would have been undertaken.

The systematic aspect of the subject has been dealt with by Watt[1] at Kew and by Gammie[2] at Poona. Watt's monograph deals more spe-

[1] *Watt, Sir George.*—The Wild and Cultivated Cotton plants of the World. London, 1907.

[2] *Gammie, G. A.*—The Indian Cottons. Memoirs of the Department of Agriculture in India. Botanical Series, Vol. 2, No. 2, 1907.

cially with the history of cotton and with the description of the various forms met with in cultivation and in the wild state. The information is given in great detail. There is a long bibliography of papers and the work, which obviously represents years of labour, should prove of the greatest value to all interested in the subject and especially to workers in India unable to consult the large libraries of Europe. Gammie has dealt only with the Indian cottons, all the forms of which he refers to one true species, *viz.*, *Gossypium obtusifolium* with its two sub-species *G. arboreum* and *G. herbaceum.*

The growing importance of the study of genetics during recent years has naturally attracted the attention of workers on this crop to this aspect of the subject. In India, Leake [1] has published an important paper on this subject, which however only deals with a small part of the work on cotton-breeding in progress at the Cawnpore Experiment Station. This paper deals with the inheritance of leaf characters and with the occurrence in field of natural cross-fertilisation. The author concludes with regard to this latter subject that "the evidence so far obtained indicates that natural crossing occurs with sufficient frequency to render it impossible to keep types pure when they are grown in the proximity of other types." Fletcher [2] has published a short paper on the inheritance of certain characters of the fibre, seed and flower and he concludes that fineness, length, and colour of the lint are dominant over coarseness, shortness and whiteness. Another investigation on inheritance in Indian Cottons carried out by Fyson at Madras, although completed during the year under review, is still unpublished. A paper of considerable importance to workers in India has recently been published by Balls [3] in which the results of this investigator during the past three years are summed up. Besides the cottons of Egypt several of those grown in India have been studied at Ghizeh. In addition to the Mendelian aspect of the question, this paper is of value to India in that it shows that the Egyptian varieties are by no means pure but that natural crossing has gone on to such an extent that the crop is now simply a mass of hybrids. The introduction of Egyptian cotton into India may therefore easily give rise to diffi-

[1] *Leake, H. M.*—Studies in the experimental breeding of Indian Cottons. Jour. and Procs. Asiatic Soc. of Bengal (New Series), Vol. IV, No. 1, 1908.

[2] *Fletcher, F.*—Mendelian Heredity in Cotton. Journal of Agricultural Science, Vol. 2, Part 3, Dec. 1907.

[3] *Balls, W. L.*—Mendelian studies of Egyptian Cotton. Journal of Agricultural Science, Vol. 2, Part 4, 1908.

culties. Under new conditions, the equilibrium between the various constituents may be upset in India and certain forms may tend to predominate resulting in a change in the quality of the cotton. Natural crossing with the Indian varieties is also probable and this would tend still further to alter the character of the crop.

A number of minor papers on Indian cotton have also appeared during the year. The history of the attempts made in the past to improve the cotton crop in Bombay has been concisely summed up by Gammie.[1] This work is best summed up in the author's own words: "The net result from the expenditure of money, skill and experience during nearly 80 years was that the new Orleans cotton was successfully introduced into the Karnatak and that it refused to grow with certainty in other parts of the Presidency. This remains the only exotic cotton now grown as an annual field crop in India. All perennial varieties have been definitely proved to be unreliable as sources of profit."

Clouston[2] has given a brief account of the methods of improving cotton in present use in the Central Provinces and Berar where the various constituents of the local *jari* cotton are being grown and tested separately. The cultivation of Egyptian cotton in Sind has been briefly described by Henderson.[3] It appears that the area sown with this crop in 1907 was 6,335 acres, while in 1905 it was only 1,000 acres. In 1907, about 2,000 acres was sown with Abassi seed obtained from last year's crop, ginned in Sind, while the remaining area was sown with Mit Afifi seed imported from Egypt. A third paper by Gammie,[4] read at the Industrial Conference held at Surat in 1907, deals with the present aspect of cotton-growing in India and the failure of past experiments. The greatly increased yield of cotton due to the application of nitrate of soda to the black cotton soil of Nagpur has been described by Clouston.[5] The soils in this locality appear to be greatly deficient in

[1] *Gammie, G. A.*—Work done towards the Improvement of Cotton in the Bombay Presidency. Agr. Jour. of India, Vol. 3, part 2, 1908.

[2] *Clouston, D.*—Note on the Measures taken for the Improvement of Cotton. Report on the Agricultural Stations in the Central Provinces for the year 1906-07. Nagpur, 1907.

[3] *Henderson, G. S.*—Egyptian Cotton in Sind. Agr. Jour. of India, Vol. 3, part 2, 1908.

[4] *Gammie, G. A.*—Cultivation of Cotton in India. Agr. Jour. of India, Vol. III, part 2, 1908.

[5] *Clouston, D.*—Artificial fertilisers for cotton. Agr. Jou .rof India, Vol. III, part 3 1908.

available nitrogen and the amount of this constituent seems to govern the yield.

Fibres.—The improvement of the fibre industry in India was one of the subjects under discussion at the meeting of the Board of Agriculture [1] held at Pusa in 1908. The report of the sub-committee appointed to deal with this subject has been referred to the Directors of Agriculture of the various Provinces in order that all available information on the subject might be collected. The complete report will be published by the Imperial Department of Agriculture.

An account of the cultivated races of jute in India has been written by Burkill and Finlow and will shortly appear in the *Agricultural Ledger.* These authors[2] have also published a paper on three varieties of *Corchorus capsularis* L. which are used as food. An account of the cultivation of Sunn hemp (*Crotalaria juncea*), Ambari (*Hibistus cannabinus*) and of the various species of Agave in the Central Provinces has been given by Clouston,[3] while two notes ([4], [5]) on the experiments now being undertaken to establish a flax fibre industry in Behar have been published in the *Agricultural Journal of India.* The principal flax experiments in Behar being conducted at Dooriah Factory are on a commercial scale and are being continued as the results so far obtained are considered to be very encouraging. With the Riga flax seed obtained from Europe for these experiments seeds of flax dodder—*Cuscuta Epilinum* Weihe—were introduced into Behar. This parasite, which so far has not been found on the indigenous varieties of linseed in India, forms the subject of a paper by the writer now in the press. Steps have been taken to stamp out the flax dodder in India and to prevent its reintroduction. A paper on the present prospects of sisal hemp cultivation in India has been written by Mann[6] who concludes that there is every prospect of the building up of a flourishing sisal hemp industry in North-East India.

[1] Proceedings of the Board of Agriculture in India held at Pusa in February 1908.

[2] *Burkill, I. H.*, and *Finlow, R. S.*—On three varieties of *Corchorus capsularis* L. which are eaten. Jour. and Proceedings of the Asiatic Society of Bengal (new series), Vol. 3, No. 10, 1907.

[3] *Clouston, D.*—Sunn hemp, Ambari and Agave as Fibre crops in the Central Provinces and Berar.—Agr. Jour. of India, Vol. III, part 2, 1908.

[4] Flax Cultivation in Bengal—Agr. Jour. of India, Vol. 3, part 1, 1908.

[5] Flax as a fibre crop in Behar.—Agr. Jour. of India, Vol. 3, part 2, 1908.

[6] *Mann, H. H.*—The Development of Sisal Hemp Cultivation in India.—Agr. Jour. of India, Vol. II, part IV, 1907.

Wheat.—Only two papers on this crop have been published during the year. An account of the wheats of Bengal by Mookerji[1] has appeared. To a very large extent the paper is a reprint of an earlier publication by Prain on the same subject. A study of the wheats of the Central Provinces by Evans is announced, while the writer has prepared for publication several papers dealing with the investigations on wheat which have been carried out at Pusa and Lyallpur during the last three years. Only one[2] of these papers has however as yet appeared. A series of representative Indian wheats have been milled and baked in England and a bulletin on this subject has been prepared. One of the Pusa wheats proved to be the best in these tests. An exhaustive study of the wheats of the Punjab which has extended over three years has been completed and a report furnished to the Director of Agriculture of that Province. A memoir on the varietal characters of Indian wheats has been prepared while the monograph on Indian wheats which includes an account of the modern methods of selection and hybridisation has been completed.

Sugarcane.—The lines of future work for the improvement of the sugarcane in India laid down by the Board of Agriculture at Cawnpore in 1907 have been adopted at the Partabgarh Experiment Station and a preliminary paper on the work done by Clarke and Hadi is in the press. A paper by the writer[3] on some of the difficulties underlying sugarcane work which was communicated to and adopted by the Board of Agriculture in 1907 has been published in England.

Fruit.—Continued attention is being paid to fruit investigations in India and an experimental garden has been started by the United Provinces Government at Naini Tal. The fruit experiments at Pusa have been extended during the year and a second report on the results so far obtained is in preparation. It is proposed to start more fruit experiments at Bhagalpur, Dacca, in the Central Provinces and also at Lyallpur in the Punjab.

Miscellaneous.—The investigations of Barber on root parasitism in Southern India which have deservedly attracted considerable attention

[1] *Mookerji, D. N.*—A short wheat survey of Bengal. Departmental Records of the Department of Agriculture, Bengal. No. 2, 1907.

[2] *Howard, A.* and *Howard, G. L. C.*—On Immune wheats.—Journal of Agricultural Science, Vol. II, Part 3, 1907.

[3] *Howard, A.*—Some difficulties in Sugarcane Experiments. Inter. Sugar Jour., 1907.

both from a practical and biological standpoint have been summed up by the author in a recent paper published at Cambridge. Root parasites have been discovered in four genera of the *Olacaceæ* and in ten genera of the *Santalaceæ*. In the paper in question a critical account of the previous literature is to be found.

A note by Gammie on rubber cultivation in Bombay has been published by the Bombay Agricultural Department and two other forthcoming works by this author are announced—one on the cereals of the genus *Setaria* and another on the field, garden and orchard crops of the Bombay Presidency. A handbook of the commercial products of India by Watt is shortly to appear.

Mann ([2], [3]) has published two papers on rubber in North-East India. He concludes that Para rubber may probably succeed in Cachar and that the methods of tapping *Ficus elastica* in Assam can be considerably improved.

List of papers on Economic Botany in India published during the year ending June 30th, 1908.

1. BALLS, W. L. Mendelian Studies of Egyptian Cotton. Jour. of Agr. Sc. Vol. II, part 4, 1908.
2. BARBER, C. A. Parasitic trees in Southern India. Proc. of the Camb. Phil. Soc. Vol. XLV, part 3, 1907.
3. BARBER, C. A. Studies in root parasitism. The haustorium of *Olax Scandens*. Mem. of the Dept. of Agr. in India. Botanical Series. Vol. II, No. 4, 1907.
4. BURKILL, I. H., AND FINLOW, R. S. On three varieties of *Corchorus Capsularis* L. which are eaten. Jour. and Proc. of the Asiatic Soc. of Bengal (new series). Vol. III, No. 10, 1907.
5. CLOUSTON, D. Note on the measures taken for the Improvement of Cotton. Report on the Agricultural Stations in the Central Provinces for the year 1906-07. Nagpur, 1907.

[1] *Barber, C. A.*—Parasitic Trees in Southern India—Proceedings of the Cambridge Philosophical Society, Vol. XIV, Part III, 1907.

[2] *Mann, H. H.*—The cultivation of Para rubber in North-East India—Agr. Jour. of India, Vol. II, Part III, 1907.

[3] *Mann, H. H.*—The tapping of Assam rubber (*Ficus elastica*)—Agr. Jour. of India, Vol. II, Part III, 1907.

6. CLOUSTON, D. . Artificial fertilisers for cotton. Agr. Journal of India. Vol. III, part 3, 1908.

7. CLOUSTON, D. . Sunn hemp, Ambari and Agave as Fibre Crops in the Central Provinces and Berar. Agr. Jour. of India. Vol. III, part 2, 1908.

8. FLETCHER, F. . Mendelian heredity in Cotton. Jour. of Agr. Sc., Vol. II, part 3, 1907.

9. FLETCHER, F. . Note on a toxic substance excreted by the roots of plants. Memoirs of the Dept. of Agr. in India, Vol. II, No. 3, 1907.

10. GAMMIE, G. A. . The Indian Cottons. Memoirs of the Dept. of Agr. in India (Botanical Series), Vol. II, No. 2, 1907.

11. GAMMIE, G. A. . Work done towards the Improvement of Cotton in the Bombay Presidency. Agr. Jour. of India, Vol. III, part 2, 1908.

12. GAMMIE, G. A. . Cultivation of Cotton in India. Agr. Jour. of India, Vol. III, part 2, 1908.

13. HENDERSON, G. S. Egyptian Cotton in Sind. Agr. Jour. of India, Vol. III, part 2, 1908.

14. HOWARD, A. . Some difficulties in Sugarcane Experiments. International Sugar Journal, 1907.

15. HOWARD, A. AND HOWARD, G. C. } On immune wheats. Jour. of Agr. Sc., Vol. II, part 3, 1907.

16. LEAKE, H. M. . Studies in the experimental breeding of Indian Cottons. Jour. and Proc. of the Asiatic Soc. of Bengal (new series), Vol. IV, No. 1, 1908.

17. MANN, H. H. . The development of sisal-hemp cultivation in India. Agr. Jour. of India, Vol. II, part 4, 1907.

18. MANN, H. H. . The cultivation of Para rubber in North-East India. Agr. Jour. of India, Vol. II, part 3, 1907.

19. MANN, H. H. . The tapping of Assam rubber (*Ficus elastica*). Agr. Jour. of India, Vol. II, part 3, 1907.

20. MOOKERJI, D. N. . A short Wheat Survey of Bengal. Dept. Records of the Dept. of Agr., Bengal, No. 2, 1907.

21. WATT, SIR GEORGE The wild and cultivated Cotton plants of the world. London, 1907.

22. Flax cultivation in Bengal. Agr. Jour. of India, Vol. III, part 1, 1908.
23. Flax as a fibre crop in Behar. Agr. Jour. of India, Vol. III, part 2, 1908.
24. Proceedings of the Board of Agr. in India, held at Pusa in February 1908. Calcutta, 1908.

MYCOLOGY.

BY

E. J. BUTLER, M.B., F.L.S.,

Imperial Mycologist.

Enquiries into cocoanut and other palm diseases in South India were continued. The Government of Madras provided the grants necessary to carry on the campaign against the Godavari palm disease for a second year. A visit was paid to Travancore to investigate a wide-spread cocoanut disease there and the results published in a report issued in March, 1908.

The general survey of Indian parasitic fungi was carried a step further, the groups dealt with being the rusts, smuts and false mildews in collaboration with Messrs. H. and P. Sydow of Berlin, and the true mildews with Mr. Salmon of Wye College.

A tour was made in Burma in January, 1908, to report on the diseases of crops in that Province and to study orange disease in Amherst District. The cause of the latter has not yet been definitely ascertained.

The study of wilt diseases of various crops, sugarcane diseases, linseed rust and diseases of citrus fruits was continued.

Publications.

BUTLER, E. J. Report on Cocoanut disease in Travancore. *Bulletins of the Agricultural Research Institute, Pusa, No. 9, March 1908.*

SALMON, E. S. Notes on some species of Erysiphaceæ from India. *Annales Mycologici, Vol. V, No. 6, December 1907.*

SYDOW, H. and P. & E. J. BUTLER.—Fungi Indiæ Orientalis, Part II. *Annales Mycologici, Vol. V, No. 6, December 1907.*

FOREST BOTANY.

BY

R. S. HOLE,

Imperial Forest Botanist.

Educational work of Forest Botanist.

1. Much of the time of the Forest Botanist was as usual devoted to the educational work of the Imperial Forest College especially during the months of July, August, September, November, March, and May. The Botanist was engaged on the preparation of a Manual of Botany for the Forest College during the year. The completed manuscript was sent to press on 1st October 1907, but publication was delayed owing to the difficulties experienced in satisfactorily and cheaply reproducing the illustrations that had been prepared. The book will, it is hoped, appear early next year.

Research work of Forest Botanist.

2. The following definite subjects for botanical research were sanctioned by the Inspector General of Forests during the year:—

(*a*) Morphological nature of the coppicing of teak and its effect on the vitality and normal development of the tree.

(*b*) Study of the forms of *Grewia* yielding the most valuable wood for shafts, tool-handles, etc.

So far as circumstances permitted the Botanist was engaged during the year on the collection of data and specimens bearing on these subjects and he was on tour for this purpose from December 4th, 1907, to 5th March 1908 in the Hoshangabad and Jubbulpore Districts of the Central Provinces and from April 30th, 1908, to June 24th, 1908, in the Jaunsar Forest Division.

As regards teak, a quantity of material in the way of observations and specimens was collected in the Central Provinces, special attention being paid to the phenomenon of the dying back of seedlings, the best method of coppicing trees of different ages, the best season for coppicing, the extent to which unsoundness spreads from the old stool to the young stems, the extent to which the coppice shoots become independent of the mother-tree and the structure of seedling and coppice stems. Seed was collected and sown at Dehra Dun for the purpose of studying the

early life-history of the seedling, the fertility of the seed of undoubted coppice shoots, the period during which the seed may remain dormant and other points.

As regards the *Grewias* the satisfactory definition of the important forest species has long been a desideratum. Considerable differences are believed to exist in the quality of the wood of certain forms which are kept distinct as separate species by some botanists and united in one species by others. As the indiscriminate mixing of good and bad timber must seriously interfere with a demand arising for the better kinds, a careful study of the characters of the different forms and of their constancy is a matter of economic importance.

The study of this difficult genus and specially of the remarkable form known as *Grewia sapida* Roxb. also promises to throw light on the question of mutations and the effect of injuries and mutilation, such as occurs in coppicing for example, on the production of new and constant forms.

A careful study of *Grewia tiliæfolia* Vahl and *Grewia vestita* Wall. was made during the Central Provinces tour as regards their mode of occurrence and variations in the forest and the same was done for *Grewia elastica* Royle and *Grewia sapida* Roxb. in Jaunsar. Seeds of the various forms were collected as far as possible and their cultivation commenced at Dehra Dun. All Forest Officers have been asked to contribute series of specimens indicating the range of variation of the different forms.

No publications dealing with research work were attempted during the year partly owing to the fact that the apparatus and appliances necessary for dealing with much of the material collected was only received in April 1908 but it is hoped to issue preliminary notes on both branches of work next year giving the results so far obtained.

Mutations.

3. The fact that coppicing and pollarding frequently result in the appearance of remarkable variations not exhibited by the uninjured plant has long been known to foresters. Thus in the case of *Pyrus Pashia* Ham. the leaves on coppice shoots are often lobed or pinnatifid while the normal leaves are crenate. A fact which is not so generally known however is that in many species such abnormal branches frequently bear flowers and fruit which also exhibit abnormal characters. This naturally suggests the possibility of such abnormal characters becoming hereditary and transmissible to the offspring. The possibility

of the evolution of new forms in this way is, it is hardly necessary to say, a matter of great importance to foresters. The researches now in hand in connection with the *Grewias* will almost certainly throw light on this interesting problem, the observations already made indicating that some of the forms at least exhibit most remarkable variations in response to mutilation.

Considerable attention has recently been paid to this subject in Europe and a very important addition to our knowledge has been contributed by L. Blaringhem in *Mutation et Traumatismes: Etude sur l' Evolution des Formes vegetales* who shows that remarkable hereditary variations may be induced by wounding.

Forest Floras.

4. Mr. H. H. Haines was engaged on his *Flora of Chota Nagpur* during the year and it is now ready for publication. Mr. R. L. Heinig published his *List of Plants of the Chittagong Collectorate and Hill tracts* during the year. Mr. D. O. Witt continued his work of the preparation of a list of species found in the Berar Circle of the Central Provinces and Mr. A. E. Lowrie commenced work on a similar list for the Southern Circle of the Central Provinces.

The preparation of small local floras with brief diagnoses enabling any English-knowing Forest Officer to quickly arrive at the correct name of any woody plant occurring in the area in his charge, together with the establishment of correctly named local herbaria, is a matter of great importance. Under existing conditions it is frequently impossible for a Forest Officer to gain a fair knowledge of the vegetation in his charge until the time arrives for his transfer to another locality, and the collection of data regarding the distribution of species, the probable yield of economic products and other important matters is much hampered by this want of knowledge on the part of local officers.

Systematic efforts have been made by local forest officers in the Bhamo Division of Burma, South Chanda Division of Central Provinces, in Baluchistan and in the Panch Mahals to collect reliable vernacular names of local species.

Herbaria and Collection of Specimens.

5. The Herbarium of the Imperial Forest College, Dehra Dun, remained as usual in charge of the Forest Botanist during the year and a considerable amount of work was done in it. More than 800 sheets were added during the year of which some 300 were very kindly sent by Mr. B. B. Osmaston from the Andamans.

The other principal contributors were Messrs. Lace who sent a most valuable set of chiefly Burmese plants, Haines who sent a large number of specimens from Chota Nagpur, Fischer who contributed a valuable set of Malabar plants, and Witt who sent a representative collection of Berar plants including a fine series of specimens of several species of *Grewia*.

Shortly after the close of the year the Forest Botanist took charge of the Saharanpur Herbarium which was at once removed and suitably housed in Dehra Dun.

Mr. A. Rodger, Deputy Conservator of Forests, has commenced a local forest herbarium in the Ruby Mines Division of Burma and the same has been done in the South Chanda Division of Central Provinces.

A list of the most useful local timbers found in the Tenasserim Circle of Burma was published during the year and a reference collection of hand specimens formed.

A large number of botanical specimens were contributed by Forest Officers during the year to the Reporter on Economic Products, the Gass Forest Museum, Madras, the Central Forest Museum, Poona, the Quetta Museum, Balaghat Training School, and others.

Distribution of Species.

6. Although occupied chiefly with the researches noted in para. 2 above, the Forest Botanist collected several species during his tour in the Central Provinces which were not included in the preliminary list of plants of the Northern Circle published last year. The necessary additions to the list will be issued next year when the collections have been worked up, but a few points of interest may be briefly noted now.

Pongamia glabra Vent. was found undoubtedly wild and almost certainly indigenous in the valley of the Tawa and other tributaries of the Narbada, in the Pachmarhi hills and along the northern slopes of the Satpuras. This species has been stated to be a littoral plant and to be only planted inland.

Berberis asiatica Roxb. was found to be common in the neighbourhood of Pachmarhi, the distribution of which has hitherto been limited to the Himalaya and Parasnath in Behar.

A species of *Rhamnus*, closely allied to and probably identical with *Rhamnus triqueter* Wall. was found common near Pachmarhi which has hitherto been known from the Salt Range, Panjab and the North-Western Himalaya. *Rhus parviflora* Roxb. is another mainly Himalayan species which is very common on the Pachmarhi hills and which

has been previously reported for that locality by both Brandis and Duthie. On the other hand *Clematis triloba* Heyne, a species of Western India and the Deccan is also common at Pachmarhi and the flora of these interesting hills is thus seen to approximate in some respects to that of the Himalaya and in others to that of the Deccan. In questions concerning plant distribution the fact of a plant being wild and reproducing itself freely is settled on sight, but the no less important point as to whether the plant is indigenous or introduced is far more difficult to answer. The existence of a sacred shrine on the Pachmarhi hills which annually attracts pilgrims from remote parts of India may possibly have been responsible for the introduction of non-indigenous species in this locality.

Asexual Reproduction.

7. Reproduction by means of coppice shoots and root-suckers continue to engage the attention of Forest Officers. Mr. Copleston, Divisional Officer, South Kanara, reports that teak seed collected from five-year old coppice germinated and produced strong healthy seedlings.

Mr. A. W. Lushington in his article "Some sucker-produced forests of the Kistna district" in the *Indian Forester*, XXXIII, 445, draws attention to the great utility of root-suckers in rapidly covering ground with a woody growth and forming good soil.

Rotation of Crops.

8. The fact that certain plants, while preparing the way and creating the conditions necessary for the development of others, thereby render their own continued existence in the locality impossible has long been recognized. On the rocky and almost treeless hills of many Indian forests we find such pioneers as *Boswellia serrata* and *Sterculia urens* playing an important part in the formation of new soil which will eventually be able to support a forest growth of different and more valuable species. The shingle banks of the Sub-Himalayan tract are frequently first covered by gregarious forests of *Dalbergia Sissoo* which gradually give place to mixed forests of inferior species and finally in many cases to a pure forest of Sal (*Shorea robusta*). Mr. P. H. Clutterbuck in his Working Plan for the fir forests of Jaunsar has also shown how inferior species such as brambles, willows and poplars prepare the way for the Spruce and Silver Fir. This phenomenon of the natural succession of different types of vegetation is one of the greatest importance for the forester, for his power of insuring the continued reproduction of his valuable species depends upon a due appreciation of the factors at work in such cases as the above.

The results of recent work published by Messrs. Schreiner, Reed and Gardner in America and by Fletcher in India and Egypt concerning the excretion of toxic substances by plants immediately attracted the attention of Indian Forest Officers who found in them a possible explanation of cases of crop-rotation, as indicated by several papers published during the year in the *Indian Forester*. While the actual excretion of a toxic substance has certainly not been proved by the work as yet published the fact does appear to have been established that under certain conditions the continued growth of a particular plant results in the accumulation of a toxic substance in the medium surrounding the plant roots which is capable of inhibiting the further growth of that plant. Whether this substance is formed inside the plant tissues and excreted, or, as seems more probable, outside the plant, by ionisation, by the action of bacteria, or otherwise, is not known.

The details of the nutrition processes however vary greatly in different species and a vast amount of research dealing with the complex factors affecting the normal nutrition of our forest trees and the relations which exist between them and other living organisms is required before we can hope to adequately explain apparently simple cases of forest crop-rotation.

9. The following are among the more important publications of 1907-08 concerned directly or indirectly with Indian Forest Botany:

C. A. BARBER . *Studies in Root Parasitism* in *Mem. Department of Agriculture in India, Botanical Series*, Vol. II, No. 4.

T. A. SPRAGUE . *Prickly fruited species of Euonymus* in *Kew Bulletin of Miscellaneous Information*, No. 1, 1908, p. 29.

F.H WOOLWARD *Germination of Poplars* in *Journal of Botany*, XLV, p. 417.

T. COOKE . . *Flora of the Presidency of Bombay*, Vol. II, Part IV.

E. BLATTER . *Contributions to the Flora of North Coimbatore* in *Journ. Bo. Nat. Hist. Soc.*, Vol. XVIII, p. 390.

E. BLATTER . *Flora of the Bombay Presidency* in *Journ. Bo. Nat. Hist. Soc.*, Vol. XVIII, 562.

A. W. LUSHINGTON *Is a period of rest and rotation of crops wanted for teak reproduction* in *Indian Forester*, XXXII, p. 409.

A. W. LUSHINGTON *Some sucker-produced forests of the Kistna District* in *Indian Forester*, XXXIII, 445.

A. W. LUSHINGTON *A plea for so-called "Worthless Species"* in *Indian Forester*, XXXIV, p. 530.

B. O. COVENTRY *Alternation of Forest Crops* in *Indian Forester*, XXXIV, p. 327.

T. E. D. INNES . *List of Jungle Products used by the Poor* in *Appendix* to *Indian Forester* for February 1908.

A. B. PUNDE . *Abnormal type of Butea frondosa* in *Indian Forester*, XXXIV, p. 358.

R. S. PEARSON . *Light and Shade* in *Indian Forester*, XXXIV, 200.

M. RAMA RAO . *Sandalwood at Sea Level* in *Indian Forester*, XXXIV, 151.

B. SEN GUPTA . *Macaranga denticulata* in *Indian Forester*, XXXIV, 281.

SYLVICULTURE.

BY

A. M. F. CACCIA, M.V.O., F.Z.S.

Up to the 23rd March 1908, the post of Imperial Sylviculturist was held by the Principal of the Imperial Forest College, and after that date the Imperial Superintendent of Forest Working Plans received charge of the office being most intimately connected with Sylviculture of which Forest Working Plans should be the expression.

Yield Tables.—The collection of statistics relating to the development of the principal timber species forms for many years to come one of the most important duties of the officers in charge of sylviculture and working plans in the Imperial Forest Research Institute. So far a certain number of figures have been locally collected, but on such a varying basis for different provinces, and with so little regard for the uniformity which is essential for collating the statistics, the utilisation of the work done is not always possible. Until a uniform procedure is intro-

duced for the whole of India and experimental work is carried out on identical lines, it will be difficult to compare and to bring together data collected by various investigators working on the same species throughout the Department.

In order to overcome this difficulty a series of experiments have been proposed and the rules governing the same suggested during the year. It is hoped that these experiments and rules, after their details have been discussed by Conservators, will be recognised as a standard in collecting statistical data regarding the development of the principal timber trees in India, and that the registers drawn up will be employed for recording the results.

Once some such principle is recognised as essential to the progress and the development of the Working Plans branch of the Imperial Forest Service, much will have been done towards concentrating the energies of the Department on the elucidation of definite problems in regular order of urgency. For an investigation of the existing experimental areas in India will probably show how little has been hitherto accomplished and how much more extended the operations must be to obtain tangible and reliable results.

Sylvicultural Systems.—An investigation was started during the year into the application of the various sylvicultural systems in Indian forests under systematic management, more particularly with reference to the methods employed in calculating the possibility. A table has been drawn up, classifying the forests for which working plans have been prepared according to the sylvicultural system in force. It will be found that the 'selection' system is the one at present almost universally employed. This system was made the subject of a very comprehensive study, and a note embodying the results of these inquiries has been prepared which will, it is hoped, whilst bringing up to date the information available on the subject, and indicating the line along which further research is required, tend to systematise the various methods at present employed in calculating the possibility.

The inquiry will now be extended to other recognised sylvicultural systems: the method of successive regeneration fellings and the 'group' system being next taken in hand. The former system has so far been practised only in the Darjeeling forests, and in the Pinus longifolia forests of the United Provinces: in both cases with the greatest success. It is now proposed to extend the method to the Monhyin teak forests of Upper Burma, and in the near future it may be found necessary to

apply it to the Terai Sal forests of the Kurseong Division of Bengal. A careful study of the application of this system to India, and of its near ally the 'group' system, is therefore indicated, particularly as regards simplifying and standardising the calculation of the possibility.

Miscellaneous.—In the course of the various investigations undertaken at the Forest Research Institute, the desirability of introducing uniformity in the definitions used in professional forestry literature has made itself felt; and with this object in view a glossary of technical terms for use in Indian forestry was prepared and issued during the year.

List of Indian Publications.

1907-08.

JACKSON, H. . Manual of Sylviculture.

MCINTIRE, A. L. . Notes on Sal in Bengal.

OSMASTON, L. S. . Experimental plantation of Albezzia Lebbek. Indian Forester, XXXIII, 177.

PEARSON, R. S. . On the natural regeneration of Anogeissus latifolia. Indian Forester, XXXIII, 231.

BEADON-BRYANT, F. . Fire-Conservancy in Burma. Indian Forester, XXXIII, 537 and 565.

LUSHINGTON, A. W. . Is a period of rest and rotation of crops wanted for teak reproduction? Indian Forester, XXXIII, 409.

PEARSON, R. S. . Level of subsoil water with regard to forests. Indian Forester, XXXIII, 57.

COVENTRY, E. M. . Note on Sal reproduction, Indian Forester. XXXIII, 174.

TULLOCH, J. C. . Working Plan for the Tehri Garhwal Leased Deodar forests.

COURTHOPE, E. A. . Working Plan for the Berkala, Dholkhand and Ranipur Ranges, Siwalik Division.

MONRO, A. V. . Working Plan for the Dungagali and Tandiani Ranges, Hazara Division.

COVENRTY, E. M. . Working Plan for the Sal forests of the Darrang Division.

DUNBAR BRANDER, A. A. . Working Plan for the forests of the Banjar Valley Reserve.

RORIE, J. J.	. Working plan for the East Yoma, Satsuwa and Tindaw reserves.
RORIE, J. J.	. Working Plan for the Tonkan Reserve.
COPLESTON, W. F.	. Working Plan for Blocks VII-A and XX of the Supa Working Circle.
OSMASTON, L. S.	The System of Agriculture combined with forestry in the Deccan of the Bombay Presidency. Indian Forester, XXXIII, 265.
JACKSON, H.	. Selection by area. Indian Forester, XXXIII, 145 and 185.
MCINTIRE, A. L.	. A Permanent method of treating selection forests without calculating the possibility. Indian Forester, XXXIII, 422.
CACCIA, A. M. F.	A Preliminary Note on the development of the Sal in Volume and in Money Value.
CACCIA, A. M. F.	. A glossary of technical terms for use in Indian forestry.

FOREST PRODUCTS.

BY

A. J. GIBSON, F.C.H.,
Imperial Forest Economist.

Forest Research Institute.—The Imperial Forest Economist and Imperial Forest Chemist were engaged on investigating a variety of articles of commerce, the raw materials of which are found in Indian Forests.

The chief subjects under investigation were an enquiry into the distribution and occurrence of Indian timbers suitable for cabinet and other fine work, which would meet a demand in the home market; the question of improving the quality and quantity of the raw lac, an industry which is annually becoming of more importance in India; the utilization of inferior Indian timbers for railway and other purposes after suitable chemical treatment to improve their durability; the possibility of making wood pulp from the Himalayan silver fir and spruce; the suitability and utilization of many Indian timbers for matches, tea-boxes, opium chests and lead pencils; and many minor enquiries, frequently started at the instance of some outside enquirer.

Strength Tests of Indian Timbers.—The Sibpur Engineering College has continued testing Indian timbers during the year though the progress made was necessarily slow.

The Products of the resin of *Pinus longifolia*.—The manufacture of oil of turpentine is now established in the Naini Tal and Jaunsar Divisions of the United Provinces and the turpentine has been the subject of analysis by the Imperial Forest Chemist with results that show that the quality of the turpentine could be greatly improved by introducing a system of steam distillation in place of the present system of heat with the addition of water. Professor Dunstan of the Imperial Institute is engaged on investigating the characteristic properties of the *Pinus longifolia* turpentine with a view to the identification of its constituents.

A great deal of colophony and turpentine, valued at some 14 lacs of rupees, is annually imported into India, and as the areas of pine forests in the country are large the local industry, if properly developed, should be capable of meeting a considerable proportion of the local requirements.

Lac.—During the year a publication on the lac insect was published as Part I, Volume I, of the Indian Forest Records. It gives in pamphlet form the state of present knowledge on the subject and the lines on which enquiries should proceed. The Economic branch of the Imperial Forest Research Institute is more concerned with the improvement in quality and quantity of the lac produced and experiments are in train to determine these conditions.

Destructive Distillation of wood.—The destructive distillation of wood, which produces such products as wood-creosote, acetic acid, methyl alcohol, acetone, etc., has been receiving attention and the results of destructively distilling various Indian timbers are now being investigated at the Imperial Forest Research Institute.

The local production of acetone to meet the demands of Indian cordite factories is of considerable importance and under the orders of the Madras Government an experiment on a commercial scale has been made in England with *Casuarina* wood with satisfactory results. The development of the industry depends largely on the possibility of arranging for a trained staff competent to supervise in the forest technical operations involved.

Antiseptic Treatment of woods.—With the ever increasing mileage of railways in India the problem of utilising the many inferior Indian timbers as sleepers gains in importance yearly and the subject is receiving due attention in the Economic branch of the Imperial Forest

Research Institute. A number of Indian timbers are being treated by the Powell process of preserving timber, through the Indian Agents Messrs. Killick, Nixon and Co. of Bombay. There seems little doubt that the process gives immunity from white ants to the timbers treated, but the experiments have not yet proceeded far enough to be able to arrive at any other definite conclusions.

Creosoting of pine sleepers was tried in India by some of the railways many years ago, but the results were not carefully recorded and a repetition of the experiment is desirable to test definitely the applicability of creosoting to Indian conditions. In order to carefully record results a stretch of experimental track to be set aside specially for the purpose, is urgently required.

Wood-Pulp.—During the year Mr. Sindall, the home paper-expert, was able to experimentally manufacture excellent pulp from the wood of the Himalayan silver fir and spruce. The question is receiving attention in the United Provinces and the Punjab and it is hoped that an experimental plant will be erected in one of these provinces to test the commercial prospects of chemical pulp, and possibly mechanical pulp as well, in India.

The Match Industry.—A gratifying amount of interest has been shown by private individuals and firms during the year in regard to the experiments now on foot in the Economic branch of the Imperial Forest Research Institute with the object of testing the suitability of various Indian timbers for making match-splints and match boxes. Thirty-five species of timbers are now being tested in Europe, a complete estimate of profit and loss on a modern equipped factory is available and the industry is likely to take a firm footing in India. The market is a large one, for the imports of matches are valued at nearly 63 lacs of rupees per annum.

Rubber.—The possibility of the profitable cultivation of rubber in India has now been firmly established and the industry can well be allowed to develop by private enterprise. The cultivation of rubber has been receiving attention in Bombay Presidency and elsewhere during the year, with uneven results, largely due to bad quality of seed employed.

Oils and oil-seeds.—The demand for edible oils and oil-seeds is very large and there are many Indian timber trees which produce oily seeds, suitable for extraction of oil and the manufacture of oil-cake. The question has occupied the Imperial Forest Chemist and Imperial Forest Economist during the year, while the Reporter on Economic Products to

the Government of India and the Imperial Institute have also been studying the matter. The scattered distribution of the trees and the want of communications often precludes the possibility of delivering these seeds to consumers at remunerative rates.

Tans and dyes.—Professor Dunstan of the Imperial Institute submitted a report to the Government of India on the relative merits of Borneo Cutch and Rangoon Mangrove extract with the result that the latter was found to have a considerably higher tanning value.

The question of the supply of tanning materials to the large leather-tanning centres in the United Provinces was under investigation during the year and the Cawnpore Chamber of Commerce is of opinion that a good tanning material is obtainable from the bark of *Acacia leucophlœa*, the wood being used for paper pulp. This opinion will probably be tested by making a commercial experiment in Norway with the wood-pulp from this species. Tanning extracts have rapidly come into favour in the home market and it seems more than likely that Indian tanning concerns will have to look in the same direction for a solution of the problem of shortage of local tanning stuffs.

Botanical and other specimens.—In March and April 1908 over 360 forest specimens illustrating the scope and forest products of the Indian Forest Department were despatched by the Imperial Forest Economist, at the instance of the Government of India, to the Franco-British Exhibition, London.

Seeds.—As usual a number of indents for seed of Indian timber trees were received and complied with during the year, many indents being from foreign countries, such as German East Africa, Austria, Chili and the United States of America.

Publications.—Several publications dealing with forest economic products were sent to the press but have not been published up to the time of writing this note.

Of the publications on forest matters the following are the most noteworthy :—

(1) ABBEY-YEATES, R. "Account of an enquiry with regard to the Candle-Nut tree (*Aleurites molucanna*) in India."

(2) CACCIA, A. M. F. "A Glossary of Technical Terms for use in Indian Forestry." (Forest Pamphlet No. 3, W. P. Series No. 1.)

(3) CACCIA, A. M. F. "A Preliminary Note on the Development of the Sâl in Volume and in Money Value." (Indian Forest Records, Volume I, Part II.)

(4) HOOPER, D. . "The Uses and Composition of Tamarind Seed." (Agricultural Ledger No. 2 of 1907.)

(5) HOOPER, D. . "The Fats of Indian Nutmegs" (Agricultural Ledger No. 3 of 1907.)

(6) MR. PURAN SINGH "Note on the Utilisation of Khair Forests in Eastern Bengal and Assam." (Forest Pamphlet No. 1, Chemical Series No. 1.)

(7) TROUP, R. S. . "Indian Woods and their Uses." (*In the press.*)

(8) TROUP, R. S. . "The Present Position and Future Prospect of the Cutch trade in Burma." (*In the press.*)

INDIAN ZOOLOGY.

BY

N. ANNANDALE, B.A., D.Sc.,

Superintendent, Indian Museum, Natural History Section.

The period covered by this Report extends from the end of August 1907 to the end of September 1908. As usual the report deals in the first instance with the zoological research done in the Indian Museum, but also includes a brief account of all work published in India and elsewhere that has a direct and immediate bearing on the study of the fauna of the Indian Empire, whether from the point of view of pure or of applied science. The only zoological subjects not dealt with are Economic Entomology, on which separate supplementary reports are submitted by the Imperial Entomologist and the Imperial Forest Zoologist; Veterinary Zoology, which is included in the report on Veterinary Science, and Zoology in medical education, which the Board of Scientific Advice has decided to be outside its province.

1. Zoological Research in the Indian Museum.

The research done in the Natural History Section of the Museum during the period under review has been of a more varied nature than

has been the case for some years past, mainly owing to the number of scientific workers whose services it has been found possible to enlist as a temporary measure.

Unfortunately, with the exception of myself, none of the workers are permanent officers of the Museum, all being either on special duty, in the temporary employment of the Trustees, or having no official connection with the Museum. The Government of India have expressed their general approval of the scheme for the permanent increase of the zoological staff of the Museum proposed by the Trustees in 1907; but the matter is still under consideration.

Survey of the fauna of stagnant water.—A collection of the aquatic animals of the Tibetan provinces of Tsung and U was made in 1907 by Captain F. H. Stewart, I.M.S., who generously presented it to the Indian Museum on condition that arrangements were made for the description of its component parts by specialists in the various groups represented. It has been found possible to fulfil this condition by distributing the collection widely, and Captain Stewart has added to our obligations not only by working out the Rotifers and Gastrotricha himself, but also by contributing an introduction to the report on his collection, which will be published shortly by the Trustees. Professor E. von Daday of Buda-Pest has written an account of the Entromostracous Crustacea and of the only water-mite obtained; Colonel H. H. Godwin-Austen, F.R.S., has described a new slug of aquatic habits but closely allied to a common European species, and M. Germaine of the Paris Museum, a new *Planorbis:* Dr. J. G. deMan in Holland and Professor L. Camerano at Turin have supplied notes on the Nematomorph worms, as I have done on a species of Hydra and on the larva of *Rana pleskii*, the only frog obtained. Captain R. E. Lloyd, I.M.S., has described the fishes, of which several are new to science, and Major J. Stephenson of Lahore, the Oligochæte worms; the leeches have been submitted to Professor Blanchard of Paris, the majority of the molluscs have been named and described by Mr. H. B. Preston in London, while Prof. von Graf of the University of Graz in Austria has kindly arranged to have the Turbellarians worked out in his laboratory. The completion of the work on this collection will add considerably to our knowledge not only of the zoology of Tibet but also of the aquatic fauna of high altitudes generally, the specimens having been obtained at above 13,000 feet. I have described in detail how the collection has been distributed to illustrate the manner in which it is necessary now-a-days to sort out even a homogeneous

collection of the kind, in order that the different groups represented in it may receive attention from their proper specialists.

The fauna of stagnant water in Indian territory has continued to occupy a great part of my own attention. Experiments are in progress as regards the biology and evolution of the sea anemone (*Metridium schillerianum*) of the brackish ponds at Port Canning, and I have described several Hydroids and Polyzoa from the same ponds, including a remarkable new genus of Entoprocta. Papers on the crustacea of the ponds based on my collections have been written by Dr. J. G. de Man, the Rev. T. R. R. Stebbing, F.R.S., and Mr. W. M. Tattersall of the Irish Fishery Board, while Dr. A. Willey, F.R.S., Director of the Colombo Museum, has recently sent to the "Records" a description of a new Polychæte and Major J. Stephenson, I.M.S., has described an aberrant Oligochæte worm.

A visit to the Western Ghats in the Bombay Presidency last November enabled me to obtain material for the study of several interesting sponges and Polyzoa, while a tour in Burma in February and March increased the opportunity of investigating the distribution of these groups, resulting in the discovery of new species of *Tubella* and *Pectinatella*, genera poorly represented in the East and not hitherto recorded from India.

At the beginning of the "rains" I made a hurried trip to the Darjeeling hills in order to obtain the eggs and larvæ of *Tylototriton*, the only Indian newt. A considerable amount of material as regards this species was obtained and other aquatic collections were made.

The whole of the Museum collection of Telphusidæ (freshwater crabs) has recently been sent to Lieutenant-Colonel A. W. Alcock, F.R.S., the late Superintendent, in order that he may prepare a descriptive catalogue of the Indian species. As this collection is perhaps the most complete of any in existence so far as Eastern Asia is concerned, Colonel Alcock's account of it cannot fail to be of the greatest importance in the study of the distribution of the aquatic fauna of the East.

Terrestrial Zoology.—I mentioned in my last report to the Board that the Trustees of the Indian Museum contemplated appointing a temporary assistant with a specialist's knowledge of the Mammalia, in order that he might work out the rats sent to the Museum as a result of the circulation of Dr. Hossack's pamphlet on the common Indian species. The honorarium that the Trustees were able to offer did not prove sufficient to attract any zoologist whose experience entitled him to be

considered a specialist; but the gentleman appointed, Mr. T. Bentham of Queen's College, Oxford, has done valuable work in re-arranging the old collection of mammals, which had of necessity been somewhat neglected in recent years. The fact that a specialist was not found to deal with the rats has proved fortunate in the end, for there can be little doubt that an expert mammalologist would have been justified in devoting his attention mainly, in the short period of time at his disposal in India, to a study of taxonomic minutiæ. Owing to the fact that a specialist was not found, moreover, Captain R. E. Lloyd, I.M.S., was put on special duty in the Museum for a period of six months—afterwards extended to a year, in order that he might study the distribution of the different Indian rats in connection with the distribution of plague. Interesting as taxonomic minutiæ may be, there can be no doubt that the work Captain Lloyd has done is of more importance both to pure and to sanitary science. The generous response that has been made to our appeal for rats measured in the flesh and properly preserved has made it possible for him not only to study the distribution of the typical forms but also to investigate their variation biologically, and at the same time to give detailed and accurate descriptions of the species or races occurring in or characteristic of a large number of localities. He has been able, further, to supply definite information correlating the absence of one common rat with the absence of plague in one of the great Indian ports. His work, it may be said, is that of a zoologist in the larger sense, acquainted with local conditions and able to make enquiries on the spot regarding points on which information was not forthcoming. The fact that he has been able to refrain from describing a single new species, although he has clearly indicated that certain species are peculiarly liable to the production of sports that may be either perpetuated or die out at once, is important. It is no exaggeration to say that in some cases he has had at his disposal hundreds of specimens for every ten that exist in European museums. The results of the work done during his year of special duty will be published shortly in a special number of the "Records of the Indian Museum," but it is to be hoped that his return to medical duty, if the medical authorities so decide, will not put a stop to the important work inaugurated by Dr. Hossack and so widely extended by himself.

Mr. Bentham, temporary assistant in the Museum, has studied the skulls, skins and skeletons of the Takin (*Budorcas*) belonging to the Museum or on permanent loan from the Asiatic Society of Bengal and has

demonstrated that the nasal chamber is very much more highly developed in the race which inhabits the Mishmi Hills on the northern frontier of Assam than in that found in Eastern Tibet. Possibly this difference may be correlated with a difference in habit, the Mishmi race living in dense jungle and therefore being obliged to trust to its sense of smell to detect the approach of enemies. Mr. Bentham has also prepared an illustrated catalogue of the collection of Asiatic horns and antlers (with measurements of all the specimens) which will be published shortly.

The earthworms of India have hitherto received comparatively little attention from zoologists, although it is recognized that no group provides better evidence in the study of zoogeography; nor was the Museum collection until recently by any means a large one. Two years ago, however, tubes of spirit were circulated all over India to those likely to assist us, with an appeal that the common earthworms of the locality to which the tubes were sent might be collected. The appeal met with generous support and a collection representative of most parts of India was obtained. The collection was submitted to Dr. W. Michaelsen, of the Hamburg Natural History Museum, who has written an exhaustive monograph on the Indian Oligochæte worms as a result of its study. The monograph will shortly be published in the "Memoirs of the Indian Museum," together with an account of the anatomy of some aquatic species of the same order by Major J. Stephenson, I.M.S., Professor of Biology at the Government College, Lahore.

It is now some years since the Museum was relieved of the burden of economic entomology by the appointment of a special officer under the Agricultural Department of the Government of India to deal with this branch of the subject. The wisdom of the separation, considering the small staff of the Museum, is now becoming apparent in the increased attention it has become possible for us to devote to taxonomic work as regards insects. The only original work that has been done recently in this direction in the Museum is Mr. E. Brunetti's revision of certain families of Diptera. During the year he has finished his account of the Bombylidæ, Leptidæ and Psychodidæ—the last family in conjunction with Dr. Annandale and Mr. Lefroy, and has made considerable progress in his study of the Tipulidæ and Sepsinæ, thus greatly extending our knowledge of the Oriental species of the order.

Scarcely less important, however, from the point of view of the study of entomology in India, is the humbler task of arranging the collections that have already been named by specialists in Europe, and of sorting

out into their families the new specimens that have recently been received, in order that they too may be sent to specialists. The progress that has been made in these directions has been great, for it is now possible to say that a large proportion of the entomological collection can be consulted with ease by the serious student, who is able to see at a glance from the labels on the specimens who is responsible for the names given them — a matter of some moment. During the last year a large proportion of the beetles have been carefully re-arranged, keeping this point in view; the whole of the Cicindelidæ have been examined and named by Dr. Walter Horn in Berlin and the Cleridæ by Dr. Schenkling in the same city, while some of the Cerambycidæ, Cetonidæ and Curculionidæ sent to the British Museum last year in connection with the preparation of volumes in the "Fauna of British India," have been returned. A valuable collection of beetles of different families sent for determination to France twenty years ago and long lost sight of, owing to the death of the specialist to whom they were sent, has also, through the kind offices of Professor E. L. Bouvier, of the Paris Museum, been sent back to India, a large proportion of the specimens named by good authorities. Similar work has been done as regards the mosquitoes, Aculeate Hymenoptera, Rhynchota and Microlepidoptera, with the invaluable assistance given us in England by Mr. F. Theobald, Lieutenant-Colonel C. T. Bingham, Mr. W. L. Distant and the Rev. E. Meyrick, F.R.S.

Marine Zoology. —One of the chief drawbacks to the scientific study of zoology in the tropics has hitherto been the belief that it is impossible to cut serial sections with a microtome at high atmospheric temperatures. It is therefore satisfactory to report that this difficulty has been proved to be rather imaginary than real. Work has recently been done in the Museum, during the rains and the latter part of the hot weather, by Captain F. H. Stewart, I.M.S., D.Sc., Surgeon-Naturalist, Indian Marine Survey, on a remarkable deep-sea worm which he considers to represent a new order of Gephyrea. The discovery of a hitherto unknown order in any group is an event of zoological importance, but the excellence of Captain Stewart's serial sections and other preparations is perhaps even more important to Indian zoology, in that it removes the only argument left to those who assert that biological research should not be attempted in Calcutta. Captain Stewart's paper will be published in the "Memoirs of the Indian Museum".

Captain R. E. Lloyd, I.M.S., D.Sc., has obtained his doctorate in

science from the University of London on a thesis consisting of the results of his investigations on marine zoology recently undertaken in the Museum. These include an account of the anatomy of the largest of known Isopod Crustaceans (*Bathynomus giganteus*) and of a peculiar Hydroid (*Nudiclava*) parasitic on a pelagic fish and differing from all other known forms in certain strongly marked characters. Captain Lloyd has also nearly ready for the press an account of the deep-sea fish dredged by the "Investigator" since Colonel Alcock's monograph on the collection was published.

I have myself commenced the preparation of an account of the Indian stalked barnacles, for the study of which the Museum collection affords unique opportunities not only owing to the "type" specimens it includes but more specially to the large number of individuals by which many of the least known species are represented.

During the past year the Museum has come into definite relations with Bengal fisheries owing to the purchase by the Local Government of a steam trawler and the generous manner in which our request for specimens of the fishes and other animals captured has been met. It is understood that a Fishery Board is about to be constituted of which the Superintendent of the Natural History Section will be a member *ex-officio*, and that a zoological expert has already been appointed to advise the Commissioner of Fisheries on technical matters. In the meanwhile progress has been made in the study of the valuable collection of large rays and other fishes presented to the Museum by the Commissioner of Fisheries. The rays are particularly valuable from a scientific point of view, because, owing to their large size, they have been little studied in the flesh by ichthyologists and are mostly known from dried skins and other imperfectly preserved specimens. Arrangements have therefore been made to obtain photographs, water colour sketches and casts of the more interesting species while the specimens are still fresh, in addition to preserving the skins and skulls. For several months Mr. B. L Chaudhuri, B.Sc., Assistant to the Commissioner of Fisheries, has devoted such time as he has been able to spare to systematic work on ichthyology in the Museum, and has, with the aid of Day's and the "Investigator" collections, been able to name the great majority of the fish taken by the trawler. Some of these appear to be new to science, although evidently not uncommon in the Bay of Bengal, while others hitherto not obtained in Indian seas or considered rare have been taken in considerable numbers.

Museum Conference in Calcutta.—A conference of delegates from various Local Governments and Native States was summoned to meet in Calcutta in December last by the Government of India. As its deliberations may have an important result as regards the study of zoology in India it may be mentioned here. Perhaps the most noticeable fact apparent in the discussions, so far as zoology was concerned, was the readiness both to give and ask for assistance from the Central Museum (Indian Museum) evinced by the curators of local museums. A full report on the Conference, which was held in the Indian Museum under the Chairmanship of Mr. (now Sir Thomas) Holland, F.R.S., Chairman of the Trustees, has been issued by the Government of India and copies have been sent to the members of the Board.

11. Work on Indian Zoology outside the Museum.

Research undertaken in India.—The investigations undertaken by Major Stephenson in the Government College, Lahore, on aquatic Oligochætes have considerable importance, while a paper on the spiny lobster of Bombay, published in the "Journal of the Bombay Natural History Society" by Dr. Arthur Powell of the Grant Medical College, is perhaps of even greater importance in that it helps to supply one of the wants felt by the student of zoology in India, namely, the lack of clear and detailed descriptions of the anatomy of the zoological types which he must examine. It is often forgotten that even the earthworms which the Indian student has to dissect belong to different families from those described in the ordinary text-books, and that the differences even between species in some orders are of a kind that puzzle a trained zoologist, unless he chances to have made a special study of the group to which the specimens whose structure he must demonstrate belong. Little progress can therefore be expected in the teaching of practical zoology until descriptions like that of Dr. Powell are available to students and teachers. Without a sound practical training, zoological research is much better left alone.

In this connection it is interesting to note the difference in the incidence of zoological research in this country and in Great Britain, in which scientific zoology is cultivated in the colleges and universities rather than in the museums. In the latter if any zoological research is

done at all, it is almost solely taxonomic; if it is otherwise, it ranks as the private work of the men who do it and not as part of their official duties. In India, on the other hand, the greater part of the pure zoological research in all branches that has been and is being done has been undertaken in connection with institutions not connected with teaching.

As regards the zoological work of private societies in India, the numerous and valuable papers published in the "Journal" of the Bombay Natural History Society are the best proof of its vitality, while the fact that a branch society and a museum have recently been established in Quetta proves that interest is taken in some branches of zoology in Baluchistan. So far as papers are concerned, the Asiatic Society of Bengal has perhaps suffered by the institution of a regular series of publications on the part of the Indian Museum; but the Museum was originally founded by the Society and still maintains its connection therewith through the Trustees appointed by the Council of the Society.

Work done in Europe and America.—I have already referred to some of the European specialists to whom collections have been distributed for identification from the Indian Museum during the year; a complete list will be found in my annual report to the Trustees for the financial year 1907-1908. The work done on the material thus sent out and on other material already in Europe, whatever the source of the specimens may be, is and must be mainly taxonomic. Few representatives of the Indian fauna diverge in structure so far from the normal as to be of special interest to students of morphology, while it is obvious that the biological aspects of Indian zoology can only be studied in India, as many interesting observations can only be made in the case of living animals.

As regards taxonomy, it is interesting to observe, as can be done by consulting the bibliography appended, that work on Indian specimens is by no means the monopoly of any one museum. Except in Calcutta, the largest Indian collections are probably in London; but the amount of Indian material on the Continent is by no means small, while the number of Continental specialists engaged in work on groups well represented in India is very large. It is therefore possible in many cases to get specimens promptly named in Berlin, Paris, Buda-Pest or Vienna which in London would be relegated to store cabinets for months or years until some specialist arose who could or had time to name them. Hence the necessity for distributing zoological collections so widely.

List of the Papers and Books having a special reference to Indian Zoology recently published.

In the *Annals and Magazine of Natural History*. A Contribution to the knowledge of the Hymenoptera of the Oriental Zoological Region. By P. Cameron. Series 7, Vol. XX, 1907, pp. 10, 81.

On the Generic Position of Benson's *Helix hyba* and the similarity of its Anatomy to that of *Khasiella vidua*, W. T. Blanford. By H. H. Godwin-Austen. *Ibid.*, p. 55.

New and little known Eastern Moths. By C. Swinhoe. *Ibid.*, p. 75.

A Subdivision of the old Genus *Nesokia* with Descriptions of three new members of the Group, and of a *Mus* from the Andamans. By Oldfield Thomas. *Ibid.*, p. 202.

New Species of African and Indo-Malayan Hesperiidæ. By C. Swinhoe. *Ibid.*, p. 430.

New Eastern Lepidoptera. By C. Swinhoe. Series 8, Vol. I, 1908, p. 60.

Notes on the Coleopterous Genus Oniticellus and Descriptions of new species from India. By G. J. Arrow. *Ibid.*, p. 178.

On the generic names of the Rupicaprine Ruminants known as Serows and Gorals. By R. I. Pocock. *Ibid.*, p. 183.

Additions to the Hymenopterous Genera *Mysine* and *Plesia*. By R. E. Turner. *Ibid.*, p. 497.

A case of Abnormal Dentition in a Dhole, or Indian Red Dog (*Cuon dukhunensis*). By R. I. Pocock. Series 8, Vol. II, 1908, p. 196

Notes on the Coleopterous Genera *Horia*, Fab., and *Cissites*, Latr., and a list of the described species. By C. J. Gahan. *Ibid.*, p. 199.

On a new species of Histeridæ and notices of others. By G. Lewis *Ibid.*, p. 137.

On some new species and sub-species of Birds from Upper Burma. By H. H. Harington. *Ibid.*, p. 244.

In the *Journal of the Linnean Society of London*. Some New Alcyonaria from the Indian and Pacific Oceans. Preliminary Notice. By Ruth M. Harrison, Lady Margaret Hall. Vol. XXX (Zoology), 1908, p. 185.

In the *Proceedings of the Malacological Society of London*. A Revision of the species of Cyclostreniatidæ and Liotiidæ occurring in the Persian Gulf and North Arabian Sea. By J. C. Melvill. March 1906, p. 20.

On a species of the land Molluscan Genus *Dyakia* from Siam. By H. H. Godwin Austen. June 1906, p. 93.

Notes on Indian and Ceylonese species of *Glessula*. By R. H. Beddome. September 1906, p. 160.

On *Glessula parabilis*, Benson. By R. H. Beddome. March 1907, p. 204.

In the *Annals of Tropical Medicine and Parasitology*. Two new Human Cestodes and a new Linguatulid. By J. W. W. Stephens. Series T. M. Vol. I, No. 4, 1908, p. 549.

What is "*Schistosomum mansoni*" Sambon 1907?. By A. Looss. Series T. M. Vol. II, No. 3, 1908, p. 153.

The Life History of *Trypanosoma lewisi*. By J. E. Salvin Moore, Anton Breinl and E. Hindle. *Ibid.*, p. 197.

Contributions to the Morphology and Life History of *Piroplasma canis*. By Anton Breinl and E. Hindle. *Ibid.*, p. 233.

In the *Transactions of the Entomological Society of London*. Notes on the Indo-Australian Papilionidæ. By P. I. Lathy. 1907, p. 1.

A Preliminary Revision of the Forficulidæ (*sensu stricto*) and of the Chelisochidæ, families of the Dermatoptera. By Malcolm Burr. *Ibid.*, p. 91.

On a remarkable undescribed form of Moth belonging to the family Lineidæ. By C. T. Bingham. *Ibid.*, p. 177.

Odonata collected by Lt.-Col. Nurse, chiefly in North-Western India. By K. J. Morton. *Ibid.*, p. 303.

On a large series of Nycteribiidæ, parasitic Diptera, from Ceylon. By H. Scott. *Ibid*, p. 421.

Notes and Descriptions of Pterophoridæ and Orneodidæ. By E. Meyrick. *Ibid.*, p. 471.

On the species of Hesperidæ from the Indo-Malayan and African Regions, described by Herr Plotz, with descriptions of some new species. By C. Swinhoe. 1908, p. 1.

Metamorphoses of two Hemiptera-Heteroptera from Southern China. By J. C. W. Kershaw and G. W. Kirkaldy. *Ibid.*, p. 59.

In the *Proceedings of the Zoological Society of London*. Contribution to the knowledge of the Anatomy of the Batrachian Family Pelobatidæ. By F. E. Beddard. 1907, p. 871.

On the Hæmogregarine from the Blood of a Himalayan Lizard (*Agama tuberculata*). By E. A. Minchin. *Ibid.*, p. 1098.

Notes upon an abnormally marked Leopard-skin from the Deccan. By R. Lydekker. 1908, p. 1.

Notes on some Species and Geographical Races of Serows (*Capricornis*) and Gorals (*Næmorhedus*), based upon specimens exhibited in the Society's Gardens. By R. I. Pocock. *Ibid.*, p. 173.

A Revision of the Sharks of the Family *Orectolobidæ*. By C. Tate Regan. *Ibid.*, p. 347.

A Revision of the Oriental Pelobatid Batrachians (Genus *Megalophrys*). By G. A. Boulenger. *Ibid.*, p. 407.

In the *Proceedings of the Royal Society*. The Life History of *Trypanosoma equiperdum*. By J. E. Salvin Moore. Series B, Vol. LXXX, 1908, p. 288.

In the *Proceedings of the Cambridge Philosophical Society*. The histology of the early placenta of *Macacus nemestrinus*. By W. L. H. Duckworth. Vol. XIV, 1908, p. 299.

On a new genus of Ixodoidea together with a description of eleven new species of ticks. By G. H. F. Nuttall and C. Warburton. *Ibid.*, p. 392.

On some new and obscure species of the genus *Hæmaphysalis* of the Ixodidæ. By C. Warburton. *Ibid.*, p. 508.

The Geographical Distribution of the Acarine Family Oribatidæ. By C. Warburton. *Ibid.*, p. 532.

In *Parasitology*. The Structure and Biology of *Hæmaphysalis punctata*, Canestrini and Fanzago. I. By G. H. F. Nuttall, W. F. Cooper and L. E. Robinson. Vol. i, 1908, p. 152.

In the *Journal of Hygiene*. Reports on plague investigations in India. Issued by the Advisory Committee appointed by the Secretary of State for India, the Royal Society, and the Lister Institute. Tom. vii, 1907, p. 324.

In *Novitates Zoologicæ*. Two new Indian Sphingidæ in the British Museum. By Sir George Hampson. Vol. xiv, 1907, p. 327.

In the *Canadian Entomologist*. On a few Oriental Geocoridæ (Hemiptera). By G. W. Kirkaldy. Vol. xxxix, 1907, p. 331.

A note on the species of *Micronecta* occurring in India and Ceylon. By G. W. Kirkaldy. Vol. xl, 1908, p. 209.

In the *Bulletin of the Museum of Comparative Zoology, Cambridge, U. S. A.* Notes on Chiroptera. By G. M. Allen. Vol. lii, No. 3, 1908, p. 25.

In the *Journal of the Bombay Natural History Society.* A Popular Treatise on the Common Indian Snakes. By F. Wall. Vol. xviii, 1908, pp. 1, 227, 525.

On the Birds of the Chindwin, Upper Burma. By A. Mears and E. W. Oates. *Ibid.*, p. 78.

Some Indian Freshwater shells. By G. Dalgliesh. *Ibid.*, p. 92.

Notes on Snakes collected in Fyzabad. By F. Wall. *Ibid.*, p. 101.

On a new Genus and some new species of Aculeate Hymenoptera collected by Lieut.-Colonel. Nurse in Baluchistan. By P. Cameron. *Ibid.*, p. 130.

Descriptions of Indian Micro-Lepidoptera. By E. Meyrick. *Ibid.*, pp. 134, 437, 613.

On the Generic position of the Groups of Squirrels typified by *Sciurus berdmorei* and *pernyi*, respectively, with descriptions of some new Oriental species. By Oldfield Thomas. *Ibid.*, p. 244.

The Drinking Habits of Wild Animals. By R. G. Burton. *Ibid.*, p. 250.

Two new snakes from Assam. By F. Wall., *Ibid.*, p. 272.

On some Indian forms of the Genus *Micromys*. By R. C. Wroughton. *Ibid.*, p. 280.

Notes on the Birds of Thandiani. By H. A. F. Magrath. *Ibid.*, p. 284.

A Contribution to the Aculeate Hymenoptera of the Bombay Presidency. By P. Cameron. *Ibid.*, pp. 300, 649.

Notes on a collection of Snakes from Khasi Hills, Assam. By F. Wall. *Ibid.*, p. 312.

Palinurus or the "Spiny-Lobster" of Bombay. By A. Powell. *Ibid.*, p. 360.

A Further List of the Birds from the Chindwin, Upper Burma. By C. Hopwood. *Ibid.*, p. 432.

Breeding habits of some snakes and lizards. By F. Dreckmann. *Ibid.*, p. 434.

Further Notes on birds of the provinces of Kashmir and Jammu and adjacent districts. By A. E. Ward. *Ibid.*, p. 461.

A new long-eared Bat from Northern India. By G. E. H. Barrett-Hamilton. *Ibid.*, p. 468.

Biological Notes on Oriental Hemiptera, No. 1. By J. C. Kershaw and G. W. Kirkaldy. *Ibid.*, p. 596.

In the *Journal of the Asiatic Society of Bengal.* Note on the

Blue or Common Heron (*Ardea cinerea*). By D. C. Phillott. Vol. iii, 1907, p. 553.

Hindustani-English Vocabulary of Indian Birds. By D. C. Phillott and G. L. Bonnerjee. Vol. iv, 1908, p. 55.

Note on the Peregrine Falcon. By D. C. Phillott. *Ibid.*, p. 259.

In the *Memoirs of the Indian Museum.* The Anatomy of *Bathynomus giganteus.* By R. E. Lloyd. Vol. i, No. 2, 1908, p. 81.

In the *Records of the Indian Museum. Nudiclava monocanthi*, the type of a new genus of Hydroids parasitic on Fish. By R. E. Lloyd. Vol. i, 1907, p. 281.

Preliminary descriptions of three new Nycteribiidæ from India. By P. Speiser. *Ibid.*, p. 295.

Annotated Catalogue of Oriental Culicidæ. By E. Brunetti. *Ibid.*, p. 297.

Notes on Oriental Diptera, No. iv. By E. Brunetti. *Ibid.*, p. 381.

Notes on Freshwater Sponges. By N. Annandale. *Ibid.*, p. 387, and Vol. ii, pp. 25, 157.

Description of a new Cyprinid Fish of the genus *Danio* from Upper Burma. By C. Tate Regan. Vol. i, 1907, p. 395.

The Fauna of Brackish Ponds at Port Canning, Lower Bengal. By N. Annandale, J. Stephenson, T. R. R. Stebbing, J. G. de Man, and W. M. Tattersall. Vol. ii, 1908, pp. 11, 39, 119, 211, 233.

Description of a new species of *Danio* from Lower Burma. By B. L. Chaudhuri. *Ibid.*, p. 125.

Rhynchota Malayana, Part i. By W. L. Distant. *Ibid.*, p. 127.

Cimex rotundatus, Signoret. By W. S. Patton. *Ibid.*, p. 153.

Fruit Bats of the genus *Pteropus* inhabiting the Andaman and Nicobar Archipelagos. By G. E. Mason. *Ibid.*, p. 159.

A new species of Sun-Bird obtained near Darjeeling. By T. Bentham. *Ibid.*, p. 167.

Three Indian Phylactomæmata. By N. Annandale. *Ibid.*, p. 169.

On two new species of Eagle-Rays (Myliobatidæ). By R. E. Lloyd. *Ibid.*, p. 175.

Description of a new species of the genus *Sesarma*, Say., from the Andamans. By J. G. de Man. *Ibid.*, p. 181.

Descriptions of new species of land, marine and freshwater shells from the Andaman Islands. By H. B. Preston. *Ibid.*, p. 187.

Description of a new Dictyonine Sponge from the Indian Ocean. By R. Kirkpatrick. *Ibid.*, p. 21.

Remarkable cases of Variation. No. 1. By R. E. Lloyd. *Ibid.*, p. 29.

Description of a new species of Lizard of the Genus *Salea* from Assam. By N. Annandale. *Ibid.*, p. 37.

Description of a new Cavernicolous Phasgonurid from Lower Siam. By W. F. Kirby. *Ibid.*, p. 43.

Description of new species of Marine and Freshwater Shells in the collection of the Indian Museum. By H. B. Preston. *Ibid.*, p. 45.

Notes on Oriental Syrphidæ. Part I. By E. Brunetti. *Ibid.*, p. 49.

Description of a new variety of *Spongilla loricata*. By R. Kirkpatrick. *Ibid.*, p. 97.

Notes on Oriental Diptera. By N. Annandale. *Ibid.*, p. 101.

On some Oriental Solifugæ with descriptions of new forms. By A. S. Hirst. *Ibid.*, p. 241.

The difference between the Takin (*Budorcas*) from the Mishmi Hills and that from Tibet, with notes on variation displayed by the former. By T. Bentham. *Ibid.*, p. 249.

On *Caridina nilotica* (Roux) and its varieties. By J. G. de Man. *Ibid.*, p. 255.

Description of a new species of *Charaxes* from the Bhutan Frontier. By G. de Rhé-Philipe. *Ibid.*, p. 285.

First Report on the Collection of Culicidæ and Corethridæ in the Indian Museum, with descriptions of new genera and species. By F. V. Theobald. *Ibid.*, p. 287.

Occasional Publications of the Indian Museum. Echinoderma of the Indian Museum: Shallow-water Holothurioidea collected by the R. I. M. S. Investigator. By R. Koehler and C. Vaney.

In the *Bulletin de la Société Entomologique de France.* Diagnoses de deux *Ancyrona* nouvelles de l'Inde (Col.), par A. Léveillé. 1907, p. 87.

Contribution à la faune indo-chinoise (Col.). Tennochilides recueillis au Tonkin par le capitaine de frégate L. Blaise, par A. Léveillé. *Ibid.*, p. 163.

Note sur les *Papilio* asiatiques du groupe d'*Alcinous* (Lep. Rhop.), par Ch. Oberthur. *Ibid.*, p. 136.

Description de Silphides et Liodides nouveaux (Col.) par G. Portevin. *Ibid.*, p. 251.

Description de deux formes nouvelles de Tennochilides (Col.), et note rectificate, par A. Léveillé. 1908, p. 212.

Descriptions de deux nouveaux *Stomoxys* du Bengale, par F. Picard. *Ibid.*, p. 20.

In the *Deutsche Entomologische Zeitschrift.* Liste des Mutillides recueillis à Ceylan par M. le Dr. Walther Horn et Description des espèces nouvelles (Hym.), par E. André. 1907, p. 251.

Berytiden und Myodochiden von Ceylon aus der sammelausbeute von Dr. W. Horn (Rhynch. het.), von G. Breddin. *Ibid.*, p. 34.

Die Arten der Gattung *Læna* Latr. (Tenebrionidæ) au dem westlichen Himalaya, gesammelt auf seinen Reisen von Herrn Karl Rost (Col.), von Edm. Reitter. 1908, p. 275.

Die Cleriden des Deutschen Entomol. National-Museums (Col.). Nachtrag ii, von Sigm. Schenkling. *Ibid.*, p. 477.

Neue indische Hemiptera, von E. Bergroth. *Ibid.*, p. 589.

Neue Erotyliden, von P. Kuhnt. *Ibid.*, p. 626.

Beitrage zur Staphylinidenfauna Ostindiens (West-Himalaya), von K. Schubert. *Ibid.*, p. 609.

In the *Zeitschrift fur systematische Hymenopterologie und Dipterologie.* Description of two new genera and four species of Indian Parasitic Hymenoptera. By P. Cameron. Vol. vii, 1907, p. 462.

On some new genera and species of Ichneumonidæ from the Himalayas. By P. Cameron. *Ibid.*, p. 466.

In the *Zoologische Jahrbucher.* Die Stimmapparat des *Hemidactylus garnoti* Dum. et Bibr. Ein Beitrage zur Anatomie der Geckotiden. (Reise von Dr. Walter Volz.) Von Leo Steck Vol. xxv (Anatomie), 1908, p. 611.

In the *Zoologisches Anzeiger.* On the systematic position of *Eunephthya maldivensis* Hickson. By S. J. Hickson. Bd. xxxiii, 1908, p. 173.

In the *Mitteilungen aus dem Naturhistorischen Museum, Hamburg.* Neue Oligochaten von Vorder-Indien, Ceylon, Birma und den Andaman-Inseln. Von W. Michaelsen. Vol. xxiv, 1907, p. 143.

In the *Stettiner Entomologische Zeitung.* Neue indomalayische Russelkafer, vorwiegend aus Madras und Borneo. Von K. M. Heller. 69 Jahrgang, 1908, p. 122.

Coleopteren aus Ostindien. Von J. Weise. *Ibid.*, p. 213.

Versuch einer monographischen Revision der Indo-Australischen Neptiden. Von H. Fruhstorfer. *Ibid.*, p. 240.

In the *Annales de la Société Entomologique de Belgique.* Pselaphides nouveaux des Indes, par A. Raffray. Vol. lii, 1908, p. 205.

In *Notes from the Leyden Museum.* Systematic Monograph of the Atlantidæ (Heteropoda) with enumeration of the species in the Leyden Museum. By J. J. Tesch. Vol. xxx, 1908, p. 1.

In the *Annales Musei Nationalis Hungarici.* Die Dipteren-Gruppe Milichinæ. Von Th. Becker. Vol. v, 1907, p. 507.

Some new Exotic Phoridæ. By C. T. Brues. *Ibid.*, p. 400.

Coleoptera nova in Museo Nationali Hungarico, descripsit E. Csiki. *Ibid.*, p. 574.

Formicides du Musée National Hongrois, par A. Forel. *Ibid.*, p. 1.

Vier Neue *Pipunculus*-Arten. Von K. Kertész. *Ibid.*, p. 579

Nouveaux Genres et espèces du Groupe des Geocorinæ. Par A. L. Montandon. *Ibid.*, p. 89.

Monographie der Carabiden-Tribus Cychrini. Von H. Roeschke. *Ibid.*, p. 99.

Nachtrag zur Monographie der Cychrini. Von H. Roeschke. *Ibid.*, p. 569.

Nouvelles Espèces d'hemiptères aquatiques, par A. L. Montandon. Vol. vi, 1908, p. 299.

Vorarbeiten zu einer Monographie der Notacanthen, von K. Kertész. *Ibid.*, p. 321.

The Fauna of British India, including Ceylon and Burma.

Mollusca (Testacellidæ and Zonitidæ). By the late W. T. Blanford and H. H. Godwin Austen.

Butterflies, vol. ii. By C. T. Bingham.

Rhynchota (Homoptera), vol. iv, pt. 1 By W. L. Distant.

Coleoptera (Chrysomelidæ), vol. ii. By Martin Jacoby.

Other Publications.

Essays on Evolution. By E. B. Poulton.

Land and Freshwater Mollusca of India, Pt. x, vol. ii, 1907. By H. H. Godwin Austen.

The Elephant's Head: Studies in Comparative Anatomy of the organs of the Head of the Indian Elephant and other mammals. Pt. I. By J. E. V. Boas and Simon Paulli.

Beitrage zur Kenntnis von *Branchiocerianthus imperator* (Allman). By E. Stechow.

Besides the papers mentioned in the above list many shorter notes, descriptions of single species, etc., have been published in the Journal of the Bombay Natural History Society and the Records of the Indian Museum.

AGRICULTURAL ENTOMOLOGY.

BY

H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S.,

Imperial Entomologist.

The study of the insect pests of crops was continued by the Imperial Entomologist, his staff and the assistants in Provincial Agricultural Departments. The detailed study of the more important insect pests was continued in the insectory and in the experimental farm at Pusa, as well as in the field, and part of a series of coloured plates, illustrating life histories of injurious insects, were circulated for use in the Agricultural Department. The reintroduction of the bollworm parasite to Sind has helped to restore normal conditions and the prevalence of bollworm in the Punjab was normal. Further investigations were made into the potato-moth and methods of storage of seed-potatoes tried at Pusa. Further trials of methods against the groundnut leaf-miner were made in Madras and the rice stem borers investigated. The problem of controlling surface grasshoppers, of checking mango hoppers and of eradicating the big cricket were specially investigated; field trials of insecticides non-poisonous to cattle were continued. New insecticides were tried and tests of patent insecticides were made at the request of agents for their sale in India. Special attention has been paid to the influence of climate upon the prevalence of insect pests and their seasonal occurrence.

The number of inquiries received and replied to has been large and the subjects covered a wide range. Insects attacking bristles, stored mohwa and cheroots have been investigated at the request of firms.

The cultivation of eri silk was continued at Pusa and in the Tapti valley, the latter by the Baroda State with assistance from Pusa. It was shown that a peculiar disease attacks the worms and this was investi-

gated by the Imperial Mycologist. The results obtained tend to show that the best direction for future work lies in encouraging the use of the silk for local use and not as an article of export, the price offered in England not being sufficiently remunerative, while the silk can be very easily employed by ryots in India without any special appliances or new processes. The cultivation of lac was continued mainly as a demonstration to students, also on indigo factories in Behar where there is a field for lac cultivation on a large scale. The food of birds has been the subject of inquiry by Mr. C. W. Mason, Supernumerary Entomologist, as also the fumigation of plant imports, grain and merchandise.

The commencement of an advanced course of teaching at Pusa has necessitated the abandonment of some lines of research formerly proposed. The work on "biting flies" mentioned in last year's report was taken over by the Second Imperial Entomologist, Mr. F. M. Howlett, who arrived in December, 1907. Since much is known of mosquitoes in India from the work of medical officers, the study of the less well-known groups was taken up including *Tabanidæ*, *Psychodidæ Chironomidæ*, and *Muscidæ*. The study of Indian Diptera has also been specially undertaken by him, the very important question of fruit-flies having been commenced during this year. Mr. C. B. Antram, Entomologist to the Indian Tea Association, has continued his work on insects injurious to tea. The treatment of mosquito blight by spraying with soap has been tried on a large scale with good results and an exhaustive enquiry into the pest has occupied the whole year.

The text of the volume on the Insects of India was completed by the Imperial Entomologist, the portion on Diptera by the 2nd Imperial Entomologist, and arrangements made for its publication. The Pusa collections of insects have now been transferred to their permanent place and completely arranged. A large part has been sent to England for the use of prospective authors of the Fauna of India volumes and much has been received back; the Orthoptera, Neuroptera, Ichneumonidæ, Braconidæ, Cetoniidæ, Chrysomelidæ, Curculionidæ, Microlepidoptera and Rhynchota Homoptera are the more important collections thus being dealt with. Collections of insects have been identified for workers in India and an exhibit collection arranged for the Madras Museum. Enquiries have been received for permission to translate Indian Insect Pests into several vernaculars and revisions in two have been undertaken by members of the Imperial Entomologist's staff. A list of the publications in agricultural Entomology is appended.

List of Publications.

Memoirs.

VOL. I, NO. 6 .	. The Mustard Sawfly.
VOL. II, NO. 1 .	. The Rice Bug.
VOL. II, NO. 3 .	. The Red Cotton Bug.
VOL. II, NO. 4 .	. The Castor Semi-looper.
VOL. II, NO .5 .	. The Tobacco Catterpillar.
VOL. II, NO. 6 .	. The Cotton Leaf-roller.

Bulletin.

BULL. NO. 7 .	. Preliminary Account of Biting Flies.
BULL. NO. 10 .	. Treatment and Observation of Crop Pests on the Pusa Farm.

Journal articles.

VOL. II, PART 3	. "Locusts in India" and "the Pests of introduced Cottons."
VOL. II, PART 4	. Practical Remedies for "Insect Pests" and "The Tse Tse Fly in India."
VOL. III, PART 1	. "The Tobacco Stem Borer."
VOL. III, PART 2	. "The Sugarcane Borers of Behar and Insect Pests of Mangel Wurzel."
VOL. III, PART 3	. "Imported Insect Pests."

The Bulletins of the Indian Tea Association published in 1907.

NO. 5. C. B. Antram. "The Bark-Eating Borers of Tea."

FOREST ZOOLOGY.

BY

E. P. STEBBING, I.F.S., F.L.S., F.Z.S., F.E.S.,
Imperial Forest Zoologist.

General.

The chief economic and scientific investigations of the year resulted from visits paid by the Imperial Forest Zoologist to the Simla Catchment Area Forests, to the Terai Sal belt of the United Provinces, and to the Kumaun *Pinus longifolia* Forests. The object of

the visit paid in April to the forests of the Simla Catchment Area, from which the water supply of Simla is drawn, was to study an attack of bark-boring beetles which had made its appearance in these forests and to prescribe the steps to be taken to counteract the attack and endeavour to stamp out the beetles.

The tour in the Terai Sal belt of the United Provinces was carried out in April-May when a study was made of the Sal bark-borer, *Sphærotrypes*, and the Sal bark and wood-borer *Æolesthes holosericea*. Other previously unreported Lepidopterous pests including a Noctuid leaf defoliator, an *Arbela* bark-eater, a Pyralid shoot tunneller and several heterocerous seed tunnellers were also studied, the results attained being of considerable economic importance.

Portions of May and June were spent in the Kumaun Oak and *Pinus longifolia* forests. Here investigations were made into the life histories of two previously undescribed species of *Scolytidæ* (*Dryocetes Hewetti*, n. sp. Steb. and *Sphærotrypes querci*, n. sp. Steb.), species of Buprestid (Amorphosoma?) and Cerambycid (*Xylotrechus*) bast and wood-borers, all infesting the oaks (*Quercus incana* and *dilatata*). In addition to studying in a sufficiently complete manner the spring and early summer stages in the life history of the *Cryptorrhynchid* weevil alluded to in last year's report as infesting the *Pinus longifolia*, the Imperial Forest Zoologist was able to make investigations into other serious pests of this tree amongst which may be mentioned a bad Noctuid bark and bast eating caterpillar and species of buprestid and cerambycid (*Stromatium*) bark and wood-borers. The bark-boring beetle (*Scolytidæ*) pests of this tree, amongst the most important of which are *Tomicus longifolia* Steb. and *Polygraphus longifolia*, Steb. and the wood-borer *Platypus?* sp., were also studied.

THE CHIEF ECONOMIC RESULTS OF THE YEAR.

(*a*) By the Imperial Forest Zoologist.

The Simla Catchment Area Bark-boring beetle Attack.

The bark-boring beetles (*Scolytus major* and *Scolytus minor*, Steb. and *Polygraphus major*, Steb.) :—

A bark-boring beetle attack in the coniferous forests of the Simla Catchment Area is of considerable importance since it is on the main-

tenance of forest on this area that the Simla water supply at present depends. The present attack was first noticed in February 1908. An examination of young infested dying deodar trees showed that the beetles present included two deodar bark-borers, species of *Scolytus*, and a species of *Polygraphus*, a beetle which generally confines itself to the Blue pine. In addition it was discovered that many trees were infested by the grubs of a species of buprestid, *Amorphosoma*? sp., the life history of which is at present unknown. Subsequent investigations brought to light that a longicorn grub also infests the trees. The attack and the measures taken to combat it were still in progress at the close of the year.

The Terai Sal Belt Pests.

Aholesthes holosericea (The Terai Sal borer).—This longicorn may be said to take the place of the *Hoplocerambyx spinicornis* beetle which infests the sal of the Central Provinces and Assam Sal belts.

The damage it does to the trees is very similar, the larvæ living and feeding in the bast layer till full grown, subsequently boring down into the heart wood to pupate. Several doubtful points in the life history were solved and it was definitely ascertained that the insect passes through one life cycle in the year.

species of insects which destroy the seed. It has become apparent that these insects differ entirely from those infesting the tree in Assam.

The Oak Pests.

The new Scolytid Bark-borers.—Two previously undescribed bark-boring beetles were discovered infesting the *Quercus dilatata* in Naini Tal. These I have described in the Indian Forest Memoirs under the names of *Dryocetes Hewetti* and *Sphærotrypes querci*. Investigations into their life histories were carried out.

The Buprestid and Longicorn Pests.—Investigations were also made on the life histories of a buprestid bast and wood-eater previously unrecorded and tentatively placed as an *Amorphosoma* and into those of three species of longicorn beetles: *Xylotrechus smei* and *Xylotrechus Stebbingi*, Gahan, the latter first recorded from Kilba, Bashahr, and into the large species of Cerambyx (probably *Lophosternus hugelii*) which is responsible for the large tunnels so often found in the heart of Hill Oak timber. It was discovered that the grub of this latter insect feeds entirely in the cambium and sap wood, not living in a winding tunnel as is the general rule of longicorn grubs, but eating out a large irregular shallow patch of bast and wood, subsequently, when nearly full grown, tunnelling into the heart of the tree.

Other Oak Beetle Pests.—Notes were also made on the life histories of the Scolytid and Platypid wood-borers, *Chramesus* (*Chramesus globulus* n. sp. Steb.) and *Diapus impressus*.

The Oak Scale Pest, Kermes himalayensis, Green in litt.—Probably one of the most interesting of the scientific investigations made in the oak belt was the discovery of a species of the scale insect *Kermes* seriously infesting old *Quercus incana* trees in the neighbourhood of Bhim Tal in the Kumaun Hills.

This is the first report of this genus being known to exist in India. With the exception of one Australian species on Acacia the genus has only previously been reported from Europe and North America where it invariably infests oaks.

The *Pinus Longifolia* Pests.

Cryptorrhynchus and Scolytid bark and wood-borers.—Allusion was made in last year's report to the weevil and bark beetle attacks to which the *Pinus longifolia* is subject. Considerable progress was made in the investigation of these attacks.

Scolytid and Platypodid Wood-borers.—Species of *Rhyncholus* and *Hylastes* tunnel into the wood of the tree in addition to the *Platypus* mentioned in the last year's report.

Noctuid Caterpillar Pest.—A serious pest of young growth was discovered in the Kalimath Plantations near Almora where a Noctuid caterpillar of considerable size was discovered feeding in the bast layer of the trees, the tunnel made usually girdling the young tree and killing it.

Buprestid and Longicorn Bark and Wood-borers.—Investigations have shown that the tree is subject to attack by two species of buprestid, a *Capnodis* and *Chrysobothris* and by a species of longicorn (*Stromatium* sp.). The larvæ of these insects feed in the bast layer only tunnelling into the sap wood to pupate.

Predaceous and Parasitic Insects.—The Histerid beetle *Niponius canalicollis*, as also species of *Platysoma* and *Paromalus* and the Clerid larvæ of *Thanasimus himalayensis*, Steb., were found to prey upon the bark and wood-boring beetles (*Tomicus*, *Polygraphus*, *Rhyncholus*, *Hylastes*, etc.) infesting the *Pinus longifolia*. A hymenopterous fly (*Ichneumon ?* sp.) grub is parasitic upon the Cryptorrhynchid weevils.

(*b*) By other Departmental Observers.

Polygraphus major, Steb. in Kulu.—The Assistant Conservator of Forests reported that this bark-boring pest was killing off saplings and poles of blue pine in the Kulu forests.

Scolytus and Polygraphus bark-borers in the Simla Catchment Area.—The attack was first reported by the Divisional Officer, Mr. A. V. Monro, I.F.S. It has been already alluded to above.

Beetle borers in Prosopis spicigera.—Considerable uneasiness has been aroused in Quetta by the discovery that the firewood imported into the station from Sind (Sukkur) contains Cerambycid grubs resembling the grubs of the Quetta borer (*Æolesthes sartus*). Both the Divisional Forest Officer at Sukkur and the Extra Assistant Conservator of Forests at Quetta are endeavouring to procure the beetle in order to settle the question as to its identity with the Quetta borer. The only insects as yet sent from Sukkur have been species of the Bostrychid wood-borers *Sinoxylon crassum* and *S. anale*, Lesne, neither of which have any connection with the larva in question.

Teak Galls from Surat.—Specimens of galls made upon the branches of Teak trees by a species of *Cicidomyiidæ* were received from Surat and also, by request, were sent from Mysore. Endeavours are being made to obtain the fly.

Rats and Hares attacking Acacia arabica in Berar.—The Divisional Officer, Buldana, and the Conservator of Forests, Mr. G. Rogers, reported serious damage from the rat (*Gerbillus indicus*) and hares to young plants of *Acacia arabica* in plantations. The stems were gnawed all round and the plants killed.

Coelosterna scabrata in Acacia arabica in Berar.—The grubs of this longicorn beetle tunnel into the roots of young plants of *Acacia arabica* and kill the trees. The damage done is considerable and the pest a serious one. The beetles strip the bark from young seedlings, thus killing them. They are assisted in this work by the buprestid *Psiloptera fastuosa*.

Balaghat Sal defoliator.—The caterpillars of the moth *Lymantria semicincta* were again reported by the Divisional Officer as defoliating Sal trees in April and again in July.

Caryoborus sp. in Cane seed at Nellore.—The Divisional Officer of Nellore reported that cane seed imported from Upper Burma was seriously infested by insects. These latter turned out to be a species of *Caryoborus*, a genus common as a seed eater throughout India.

The Mango Borer in Ganjam (Batocera sp.).—Allusion was made last year to the longicorn beetle *Acanthophorus serraticornis* as infesting mango in Ganjam. Subsequent investigations and correspondence have disclosed the fact that the true mango borer is a species of *Batocera*. So far as is at present known *A. serraticornis* does not infest mango.

Acacia arabica defoliators in Guntur, Madras.—The larvæ of the Lymantriid moths *Euproctis lunata* and *E. rhoda* were reported as very severely defoliating *Acacia arabica* trees, both leaves, twigs and pods being devoured in February-March. The moths appeared in April-May.

The 'Bee-hole' borer of Teak in Tounghoo.—This insect was reported by the Deputy Conservator of Forests as fairly common throughout the teak forests of Tounghoo.

Monophlebus tectonæ? in the Upper Chindwin.—This scale insect was reported for the first time from the Chindwin forests. Its identity with the *M. tectonæ* has not yet been satisfactorily settled owing to the specimens sent being immature.

Teredo marine-borer in Bamboos.—Experiments made in Tennasserim with bundles of various species of bamboo anchored in tidal waters have shown that all are subject to the attacks of the Teredo borer.

Andamans Padouk Weevil and Scolytid Wood-Borer.—Mr. B. B. Osmaston reported that Padouk seedlings are ringed and killed by a tiny weevil (*Baridius* sp.) in the Andamans. The life history of this insect is at present unknown. The same officer also reported that Padouk timber when stacked on land was subject to the attacks of a minute Scolytid insect which has been identified as a species of *Xyleborus* or closely allied genus.

(*c*) By other Observers.

Scarabæidæ in Grass Lawns at Quetta.—The Agent to the Governor General in Baluchistan reported that grass lawns in Quetta were seriously infested by the grubs of beetles which turned out to be specimens of *Melolonthidæ* or cockchafers.

A Longicorn borer in the Zhob Forests.—The Political Agent, Zhob, Captain E. H. James, reported that the Chilgoza (*Pinus Gerardiana*) trees in the North Zhob forests were infested by a species of longicorn beetle which proved to be *Stromatium barbatum* or a closely allied species.

Some notes on the life history of this insect were submitted by the Political Agent.

The Pinus gerardiana bark beetles of Zhob.—The Political Agent, Zhob, submitted a report showing the steps taken to continue the attack against the bark beetle infestation in the *P. Gerardiana* forests.

Chief Scientific Results of the year.

Foremost in the scientific results of the year may be placed the discovery that the genus *Kermes* (Family *Coccidæ*) is present in India, this being apparently the first record of its existence in the region.

The discovery and description of undescribed species of *Dryocetes* and *Sphærotrypes* is of scientific interest.

Species of *Hymenoptera* parasitic upon the *Chrysobothris* buprestid beetle infesting the deodar and upon the larvæ of *Scolytus major*, also infesting the deodar, have been bred out and the flies obtained.

The identification of these insects should prove of high interest and value.

List of Publications.

STEBBING, E. P. . *Lecanium capreæ* as a pest to Almond trees. Indian Forester, XXXIII, 168.

STEBBING, E. P. . *Icerya Ægyptiaca*, on Teak in Burma. Indian Forester, XXXIII, 222.

STEBBING, E. P. . The Shot-Borers of Bamboo and Wood-Borers of *Pinus longifolia*. Journal, Bombay Natural History Society, XVIII, 18.

STEBBING, E. P. . On Some Assam Sal (*Shorea robusta*) Insect Pests: with notes upon some Insects predaceous and parasitic upon them. Forest Bulletin No. 11.

STEBBING, E. P. . A Note on the Lac Insect (*Tachardia lacca*), its life history, propagation and collection. Indian Forest Records I, 1.

STEBBING, E. P. . A Manual of Forest Zoology for India (Illustr.) Government of India Press, Calcutta. (1908.)

STEBBING, E. P. . The Bark-boring beetle Attack in the Coniferous Forests of the Simla Catchment Area. Forest Pamphlet No. 2, Zoology Series, No. 1.

STEBBING, E. P. . The Terai Sal bark-borer (*Sphærotrypes siwalikensis*). Leaflet No. 1, Zoology Series.

STEBBING, E. P. . The Teak leaf defoliator (*Hyblæa puera*). Leaflet No. 2, Forest Zoology Series.

STEBBING, E. P. . The Teak leaf Skeletonizer (*Pyrausta machæralis*), Leaflet No. 3, Forest Zoology Series.

VETERINARY SCIENCE.

BY

COLONEL H. T. PEASE, C.I.E., I.C.V.D.,

Inspector-General, Civil Veterinary Department in India.

In the Imperial Bacteriological Laboratory at Muktesar the output and issue of the various products prepared were considerable and occupied the major portion of the time of the staff.

The following table shows the preparation and issue of these during the year:—

NAME OF SERA.	Quantity prepared.	Quantity issued.	Increased or decreased manufacture as compared with last year.	REMARKS.
	Doses.	Doses.	Doses.	
Anti-rinderpest	482,833	440,585	+14,840	
Anti-anthrax	16,091	38,772	+811	
Hæmorrhagic Septicæmia.	188,796	112,713	+99,921	
Charbon Symptomatique.	300	2,100*	—17,569	*Balance in hand during the past year being sufficient to meet requirements.
Mallein	3,753	7,926	—7,523	Ditto.
Tuberculin	34	75†	...	†Enhanced issue from the stock of previous years.

Rinderpest.—The preparation of anti-rinderpest serum for use by the serum alone method—the only means at present possible for dealing with rinderpest in India—has been continued and an increase in output is noticeable. Several improvements connected with the routine method of preparation have been effected.

Anthrax.—The question of the success of the serum alone method of protecting animals against this disease in the field has been studied. The conclusions which have so far been arrived at are that although it is not altogether a satisfactory method for the reason that the passive immunity which it gives is of short duration and that no rigorous hygienic measures can be adopted in this country, still, it is the only one which we can at present make use of. It is, in some cases, useful and may be continued in certain special circumstances. We have been recommended to adopt some of the known methods of giving protection against the disease in India. This is, in the great majority of instances, quite impossible. As a matter of fact we know very little indeed regard-

ing the prevalence and importance of the disease in India and, with the staff at present available, cannot hope to greatly increase our knowledge for many years to come. We require better organisation and a more highly trained staff before it will be possible to make much progress in mapping out the zones in which anthrax is enzootic and in determining where we shall be justified in attempting to apply any of the recognised protective methods. A preliminary step has been made in this direction by asking the Provincial Superintendents to gradually map out the areas where the disease is detected and especially those in which the diagnosis has been confirmed by microscopical or biological tests.

In order to obtain some useful knowledge regarding the disease as it occurs amongst animals in this country, the following questions have been studied in the Imperial Laboratory :—

(i) The susceptibility of the horse, ox and sheep of India to experimental inoculation.

(ii) The practical value of the use of anti-serum alone.

(iii) Various methods of preparing a serum of high protective power.

(iv) The immunizing properties of dead bacilli and other products of anthrax culture.

(v) The value of the practical application of the simultaneous injection of serum and virus.

The latter appears to us to be the method most suitable for use in India when we are in a position to use one at all. The results so far obtained in cattle are very promising but more work is necessary before any definite opinion can be formed. The investigation is proceeding.

Hæmorrhagic Septicæmia.—The question of dealing with this troublesome disease in the field has also received attention. On a careful consideration of the nature of the disease and the protective power of the serum in use, it did not appear to be likely that much good could possibly result from its use in the field and it has consequently been stopped.

The results of the work in the laboratory show (*a*) that a serum capable of conferring immediate immunity for about a month's duration can be prepared, (*b*) that dead vaccines can be used for immediate protection of somewhat longer duration.

Enquiry is being made into the practicability of (*a*) serum and virus and (*b*) dead vaccine and virus. This will be continued.

Charbon Symptomatique—The single vaccine prepared in pillule form by Messrs. Parke Davis & Co. has proved exceedingly suitable to the

conditions at present prevailing in the country and has met with the approval of Superintendents who have had occasion to deal with this disease. After numerous experiments, Captain Holmes has succeeded in preparing a single vaccine in pillule form for use in the districts. The laboratory tests of this vaccine have been very satisfactory, no casualties occurring after its use and an active immunity being established in from two to three weeks. A full report of this research will be published in the Journal of Tropical Veterinary Science.

Experimental treatment of Surra.—A few experiments were made regarding the value of Atoxyl alone, Atoxyl with Perchloride of Mercury and Tartar Emetic. A report of this investigation was published in the Journal of Tropical Veterinary Science. A further series of experiments on the treatment and prophylaxis of Surra by means of the combined use of Atoxyl and Orpiment are being conducted and the results so far obtained are hopeful.

Cattle Lymphangitis.—An investigation into a form of lymphangitis occurring amongst cattle in Calcutta and locally known as "Calcutta sores" was made by Captain Holmes. The details of the work done on this subject are published in the Journal of Tropical Veterinary Science, No. 3, Vol. III, page 289.

Ratin.—The practical value of this virus was tested by Captain Holmes at Muktesar and more thoroughly by Mr. Gaiger at the Panjab Veterinary College laboratory and in the field. The reports have not been published but the experiments proved that the virus is of no value in this country.

Camel diseases.—Investigations into the diseases of the camel have been commenced, a definite scheme of enquiry having been adopted. The most important points which have so far suggested themselves are as follows:—

In the first place, Surra appears at present to be the most prevalent and fatal disease affecting these animals. From investigations I have made extending over four years, it appears that camels which are the subject of it may live for that time carrying the parasite in their blood, but that even when kept in the most favourable conditions, *i.e.*, when well fed and not worked, very few of them recover after long periods of illness and that those which do recover are of little use.

No cure has yet been found.

Ever since surra was discovered by Evans the cause of spread has been considered to be a biting fly which acts as a mechanical transmitter of the disease. Steps are being taken to confirm this by experiment,

and Mr. Leese will form a temporary laboratory in a surra zone during the ensuing surra season for the purpose.

The flies, ordinarily, in Northern India at any rate, are seasonal, appearing in the summer and disappearing in the autumn. This appears to be the cause of what is known as the "Surra season." That is to say that when they are present the disease assumes an epizootic form and when they disappear it ceases to spread. Moreover, the flies ordinarily live in zones having the same physical character, *i.e.*, jungle land, subject to inundation and marshy. Thus, they are very plentiful along the banks of rivers covered with undergrowth, on marshes, etc. It is in such zones that surra is most prevalent.

For the spread of surra, three things appear necessary:—

(i) A reservoir of the virus, *i.e.*, an animal carrying the parasite in its blood. The camel itself, owing to the length of time which it may remain alive when diseased, and to the fact that at short intervals the parasites are numerous in the peripheral circulation, forms an ideal reservoir of the virus. Other animals, especially cattle and buffaloes, have also been proved to carry it without showing symptoms of the disease.

(ii) A means of transmitting the parasite from the diseased animals' blood to that of a susceptible animal. This, from experiments already made and from the analogy furnished by other forms of trypanosomiasis as well as from observations made with surra in Malaya, exists in the form of biting flies—such as Tabanus, Hæmatopota and Stomoxys. Collections of such flies are being made and their transmitting power tested.

(iii) The presence of susceptible animals. These are healthy camels and other animals. If the above statements be proved to be correct, it is easy to understand that a camel suffering from surra is a source of great danger to others in its vicinity at the time when biting flies are prevalent.

With these facts before us, the first step in our investigation is to ascertain the death rates in different localities and the seasonal and geographical prevalence of the disease. Mr. Leese has since his appointment been devoting attention to this point and Provincial Superintendents have been asked to collect whatever information they can in regard to it. We may thus hope, in the course of time, to obtain a reliable record of dangerous zones which may be of use to us in avoiding them during the season when flies are prevalent. We

must get rid of all camels which are dangerous to others by forming a reservoir of the virus, and careful examinations of the blood are being conducted as often as possible so as to prevent the diseased going to work and graze with healthy animals in dangerous localities when biting flies are prevalent. It is obviously necessary to provide camels with suitable surra free grazing grounds which is the chief means of keeping them free from surra.

These then are roughly the lines on which the enquiries into Surra amongst camels are proceeding and a good deal of information has already been collected in connection with the incidence of surra in the various Camel Corps and the probable causes of it. The importance of early diagnosis of the disease so as to secure the early removal of diseased camels from amongst the healthy ones, the necessity for avoiding dangerous zones in the fly season have been illustrated by the mortality which annually resulted amongst the camels of the Lahore Corps as the result of their passage through the surra zones in the Gurdaspur district during the fly season. The danger of marching surra camels with other susceptible transport animals was also forcibly brought to notice on that route, mules becoming infected from the camels. These points have already been brought to the notice of Government.

The necessity of employing another specially qualified officer for camel work has already been brought to notice, but sanction cannot be obtained for the appointment at present. Other epidemic diseases of the camel have been noticed. Tuberculosis; Wail, apparently due to a Stomach Strongyle; Camel Pox: Jhoolak; Gal Sujha; and Filariasis, which will be investigated when time and opportunity can be found.

The preliminary report on work done by Mr. Leese is being published.

College laboratories.—Those at the Panjab and Bengal Veterinary Colleges have been working during the year, but owing to there being no whole time Pathologist available, the officers have been unable to do much beyond diagnosis and teaching work in them.

A list of publications contributed during 1907-08 from the Imperial Bacteriological Laboratory.

HOLMES, J. D. E. . Investigation of an outbreak of Horse Surra with result of treatment with Atoxyl, Tartar Emetic, Mercury and other drugs. Journal of Tropical Veterinary Science, Vol. III, No. 2, page 157.

HOLMES, J. D. E. . A peculiar form of Streptotrichosis among cattle. Journal of Tropical Veterinary Science, Vol. III, No. 3, page 289.

A list of papers published during 1907-08 bearing on such diseases.

ANTONIO PRICOLO . Contribution to the study of Epizootic Lymphangitis. Journal of Tropical Veterinary Science, Vol. III, No. 2, page 217.

ASCOLI, A. . . Experimental Researches into the Accidents consecutive to Anti-anthrax inoculation. Journal of Tropical Veterinary Science, Vol. III, No. 1, page 71.

BALDREY, F. S. H. Hæmorrhagic Septicæmia of cattle, and its relation to Preventive Vaccination. Journal of Tropical Veterinary Science, Vol. II, No. 3, page 287.

BALDREY, F. S. H. Aggressins in Barbone and their application as an Immunising Agent. Journal of Tropical Veterinary Science, Vol. II, No. 4, page 351.

CAZALBOU, L. . A Note on "Baleri." Journal of Tropical Veterinary Science, Vol. III, No. 1, page 85.

EVANS, G. H. . On the care of Elephants. Journal of Tropical Veterinary Science, Vol. II, No. 4, page 356.

EVANS, G. H. & T. RENNIE. Notes on some Parasites in Burma. Journal of Tropical Veterinary Science, Vol. III, No. 1, page 13.

FRANCISQUE JANIN Researches into the Sarcosporidia of the sheep. Journal of Tropical Veterinary Science, Vol. III, No. 1, page 36.

GAIGER, S. H. . Cœnurus serialis found in two goats in India. Journal of Tropical Veterinary Science, Vol. II, No. 3, page 316.

GAIGER, S. H. . Demodex ovis. Journal of Tropical Veterinary Science, Vol. III, No. 2, page 173.

GARIBALDO LISI . Fibrous Nodules of the Liver of a Horse. Journal of Tropical Veterinary Science, Vol. II, No. 3, page 333.

GIOVANNI MAZZINI Experiments regarding the Diagnosis of Anthrax. Journal of Tropical Veterinary Science, Vol. III, No. 2, page 207.

HARRIS, NORMAN MACL. A Method of Preparing the Romanowsky Stain. Journal of Tropical Veterinary Science, Vol. III, No. 1, page 92.

HUTCHEON, D. . Biliary Fever in Dogs. Malignant Jaundice or Canine Piroplasmosis. Journal of Tropical Veterinary Science, Vol. II, No. 4, page 402.

LAVERAN, M. A. . The Trypanosomiases of the Upper Niger. Journal of Tropical Veterinary Science, Vol. II, No. 4, page 364.

LUIGI-COMINOTTI . Ulcerative rhinitis in a horse simulating Glanders. Journal of Tropical Veterinary Science, Vol. III, No. 2, page 228.

MARCONE, D. G. . Saccharomycosis of the Nasal Fossæ of the horse simulating Glanders. Journal of Tropical Veterinary Science, Vol. III, No. 1, page 80.

MONTGOMERY, R. E. On a Spirochæte occurring in the blood of Chickens in Northern India. Journal of Tropical Veterinary Science, Vol. III, No. 1, page 1.

MORAX, V. . . Ocular manifestations in the course of Trypanosomiasis. Journal of Tropical Veterinary Science, Vol. II, No. 3, page 322.

PEASE, H. T. . Susceptibility of the Indian Dog to Dourine. Journal of Tropical Veterinary Science, Vol. II, No. 3, page 310.

PEASE, H. T. & W. D. GUNN. A résumé of our knowledge of Canine Pyroplasmosis with an outbreak amongst the Hounds of the Madras Hunt. Journal of Tropical Veterinary Science, Vol. III, No. 2, page 175.

REMLINGER, P. . Spontaneous recovery of experimental Rabies in the Dog and the Persistence of the Rabic Virus in the Saliva of recovered animals. Journal of Tropical Veterinary Science, Vol. II, No. 4, page 393.

SCHBIN, H. . Contribution to the Study of Surra in Indo-China. Journal of Tropical Veterinary Science, Vol. III, No. 2, page 191.

SCHEIN, H. . Hæmatozoa of Bovidæ in Indo-China. Journal of Tropical Veterinary Science, Vol. III, No. 2, page 202.

THEILER, A. . Experiments with serum against East Coast Fever. Journal of Tropical Veterinary Science, Vol. II, No. 3, page 249.

THEILER, A. . On the correlation of various Diseases in Stock in South Africa. Journal of Tropical Veterinary Science, Vol. III, No. 1, page 33.

THIROUX, M. . Animal Trypanosomiasis in Senegal. Journal of Tropical Veterinary Science, Vol. II, No. 4, page 417.

WALKER, G. K. . A practical method of determining the dose of serum required to protect contact animals in outbreaks of Rinderpest. Journal of Tropical Veterinary Science, Vol. III, No. 1, page 28.

PROGRAMMES OF WORK FOR 1908-09.

PROGRAMMES OF WORK OF THE VARIOUS SCIENTIFIC DEPARTMENTS FOR THE YEAR 1908-09, AS APPROVED BY THE BOARD ON THE 11th MAY 1908.

1.—The Imperial Institute, London, and the Department of Economic Products, Calcutta.

Programme enumerating the chief enquiries to be undertaken by the Reporter on Economic Products and (Part 2) at the Imperial Institute. Enquiries in the hands of the Reporter on Economic Products are enumerated in the report and programme of his department for 1907.

1. Investigations of myrrh, frankincense, byssabol, habaghadi and allied products will be continued.

2. Investigation regarding the use of *Baccaurea sapida* as a dye stuff or dyeing auxiliary will be continued.

3. The investigation of the following indigenous drugs will be continued:—*Adhatoda Vasica, Alstonia scholaris, Calotropis procera, Cæsalpinia Bonducella, Embelia Ribes, Ipomæa hederacea, Picrorhiza Kurrooa, Podophyllum Emodi.*

4 and 5. An attempt will be made to complete the Reports on Juar (*Sorghum vulgare*) and Yams (*Dioscorea spp.*) mentioned in previous programme.

6. The enquiry on the origin of native pens will be concluded.

7. The study already in hand of the nature of Indian lemon oil grasses —a continuation of Dr. Stapf's work—will be prosecuted.

8. Material for the study of *Colchicum luteum* as a poison will be supplied to the Pharmacological Laboratory, Cambridge.

9. *Rices.*—Analyses will be made of the chief commercial rices of the Central Provinces, Nepal and Madras in continuation of the enquiry into the composition of Indian rice grains.

10. *Fixed oils.*—Examinations are being made of the minor fixed oils of the country, such as those obtained from the seeds of cucurbitaceous plants, the Terminalia nuts, and a few others about which very little is known.

11. *Lac.*—An investigation will be continued into the composition of crude lac collected under varied conditions; and an endeavour will be made to solve certain questions connected with the manufacture of shellac.

(PART 2).—*Chief investigations in hand at the Imperial Institute.*

Indian Aconites.—The investigation of the alkaloids present in the roots of the following species of Indian aconites will be continued during the year. *Aconitum palmatum, Aconitum heteropylloides, Aconitum soongaricum, Aconitum spicatum, Aconitum laciniatum* and the hybrid *Aconitum laciniatum x spicatum.* It is hoped that it will be possible to complete the chemical examination of the alkaloids present in these species.

Solanaceous Drugs.—Eighteen Solanaceous drugs, including *Datura Stramonium, Datura fastuosa* and *Hyoscyamus reticulatus* have been received, and the amount and nature of the several crystalline alkaloids present in a selection of these drugs are being determined.

Indian Turpentine.—The oleo-resin, derived from *Pinus longifolia* is under investigation. The constituents of the turpentine oil are being determined and a comparison of the constituents of the colophony with those of French and American colophony of commerce is being made. In extension of this investigation about 28 pounds of the oleo-resins obtainable from other Indian pines such as *Pinus Gerardiana, Pinus Khasya* and *Pinus Merkussii,* are to be collected for the purposes of comparative examination.

The following minor enquiries will be conducted :—

Cyanogenetic glucosides.—Further investigations will be conducted, especially with reference to the varieties of Rangoon beans (*Phaseolus lunatus*) which furnish considerable quantities of prussic acid.

Oilsand Oil Seeds.—The oil obtained from the seeds of *Amoora Rohituka* and the fats prepared from the seeds of *Bassia butyracea, B. longifolia* and *B. latifolia* will be investigated. The seed and fruits of the Bassias will be examined. A supply of the seeds of *Schleichera trijuga* has been asked for, so that their constituents, other than oil, may be investigated.

Fibres and Cotton.—During 1907-08 a large collection of reference samples of cotton and of botanical specimens of cotton plants was received from the Economic Botanist at the Ganesh Khind Botanic Gardens, Poona, and it is desirable that the transmission of such samples to the Imperial Institute should be continued so that they can be added to the permanent reference collection of cottons now maintained in the public exhibition galleries of the Imperial Institute. A sample of the fibre of *Dregea volubilis* is under investigation.

Rubbers.—*Ficus elastica* and *Ceara* rubbers, the former from Mukkie Malabar, and the latter from South Arcot, will be examined.

Resins.—The resin of *Canarium bengalense* will be examined and its commercial value ascertained.

Drugs.—In addition to the Aconites and Solanaceous drugs referred to above, the constituents of the seeds of *Strychnos potatorum* and of the roots of *Thalictrum foliolosum* will be examined.

Minerals.—The enquiries conducted on behalf of the Geological Survey with reference to pottery clays and laterites will be completed.

2.—Meteorological Department.

Astronomy.—It is proposed to do the following work at Kodaikanal :—

1. Daily photographs of the sun with photoheliograph.
2. Ditto ditto spectroheliograph (both disc and limb).
3. Observations of prominences (visual).
4. Study of sunspot spectra (visual and photographic).
5. Photographic study of prominence spectra.
6. Measurement of rotation speed of higher gases of the chromosphere.
7. Study of flocculi in relation to sunspots.
8. Distribution of the various types of prominences.
9. Distribution of dark linear markings on flocculi plates.
10. Study of long-enduring prominences in high latitudes.
11. Photograhhic comparison of the light of the moon and Jupiter with first magnitude stars, with a view to the detection of possible periodic variations in the solar radiation.
12. Study of solar radiation with Angström's Pyrheliometer.

Meteorology.—*Registering balloons.*—It is proposed to make special endeavour this year to secure meteorograph records of temperature and humidity up to great heights by means of small balloons. At four nearly equidistant periods between April and December batches of registering balloons will be liberated at some place in the west of the Punjab and organised efforts will be made to recover as many as possible on descent. Each batch will comprise perhaps ten complete units, the adjustment and liberation of which will take between a week and ten days It is hoped to reach heights of 25,000 feet in the earlier experiments, and later in

the year when experience has been gained to increase the heights at which the balloons are caused to descend until 50,000 feet has been reached. It is important to reach this height in order to see whether the isothermal zone which has been almost invariably found at or near that level by sounding balloons in Europe is to be encountered over India.

Kites.—It is doubtful whether in the absence on leave of the head of the department the programme proposed for balloon ascents will allow of kite work this year, but it is hoped that even if a visit to Belgaum for the purpose prove to be impracticable, some kite work may be done in Simla at special periods. If so, records will be obtained by means of apparatus which was partly developed last year during kite flights in the plains, and now promises well. It consists of a very light meteorograph (weight about 2½ oz.) which is attached to a sailing traveller arranged to run up the kite wire before the wind, and on nearing the kite to throw away its sail and descend to the operator at the kite engine.

This apparatus which was successfully used up to a height of nearly a mile over the middle of the Arabian Sea last year secures very nearly simultaneous records of temperature and humidity throughout the layers traversed, a result which has not before been attained outside of India.

Atmospheric Electricity.—An endeavour will be made to get complete records of the three following elements of atmospheric electricity:—

(1) The potential gradient by means of a Benndorf self-registering electrometer and a radium collector:

(2) The conductivity of the air by means of a specially designed apparatus which will photographically record in a continuous manner the changes in atmospheric conductivity for both positive and negative electricity:

(3) The quantity of electricity brought down by rain during thunderstorms, with the special object of determining if more negative than positive electricity is carried down.

Laboratory experiments are also being undertaken for the purpose of throwing some light on the production of electricity in thunderstorms.

Seasonal variations of climate.—It is proposed to continue the attempt to obtain light on the changes in the strength of the monsoon currents and in the quantity of cold weather precipitation. For this purpose statistical methods will be employed as well as recent information from ships and observatories.

Seismography.—Movements of the earth are at present recorded by Omori seismographs at Simla and Bombay, and by Milne seismographs at Alipore, Kodaikanal and Bombay.—A second Omori instrument will shortly be installed at Simla.

TERRESTRIAL MAGNETISM.—The routine measurements by means of absolute and variation instruments at Alibag will be continued. The preparation of the sixty years' record at Colaba for publication is not yet completed owing to the need of examining the temperature coefficients and the causes of discrepancies in the earlier portion of the period: these investigations appear to have been successful and it is hoped that printing will begin in June next.

Appendix to the Programme of the Meteorological Department.

Report on the recommendations contained in paragraphs 4 and 5 of a letter dated 14th November 1907, from the Royal Society, London, to the Under-Secretary of State, India Office.

1. The view of the Observatories Committee that every effort should be made to secure observations by means of small balloons up to a height of 50,000 feet involves a material extension of the suggestions which our programme was intended to convey. We have already made preparations for sending up small unmanned sounding balloons in fairly calm weather to a height of 10,000 feet, and expect that on their descent, which is automatically secured by the instruments carried, they would usually alight not further than six miles away from the starting point: there would thus be a good chance of their being followed up by coolies employed by us and found with the self-registering instruments still attached to them. I fear, however, that a balloon which would rise to 50,000 feet would have to remain in the air for at least four hours; it would then probably alight at some place between 40 and 200 miles from the starting point, for winds of 100 miles an hour are frequently met with at great elevations in India.

2. Balloons rising to such heights are now employed in practically all civilised countries, and a large proportion of those sent up are sooner or later found and returned. In India, however, the chances of recovery are much smaller than in other countries where such work is done and it was for that reason that our programme was arranged on a less extensive scale than that now proposed.

3. Some preliminary experiments on a small scale were made during February in Lahore, and as a result of them I am now able to propose the following scheme, in order to carry out the recommendation of the Observatories Committee. The main ideas in my proposal have been adopted with success in other countries, but the details have been modified to suit Indian conditions—

(*a*) A visit would be made in May to some place in the Punjab where the surrounding country is flat, free from forest land, well populated and at some distance from native territory; about 10 balloon outfits would be liberated from there. At this stage of the work it would appear advisable to be satisfied with heights not exceeding 25,000 feet because at that altitude the winds of very high velocity are seldom reached, and the point of alighting would be near enough to the starting point to afford a good chance of the recovery of the instruments within a few days.

(*b*) In the light of the experience gained in May three further series of ascents would be made, in July, September and December. These would be similar in general character to the May ascents, but would be greatly extended as regards height to be reached in order to meet the recommendation of the Observatories Committee.

(*c*) The self-recording apparatus to be used would be somewhat similar to Mr. Dines' instrument as used in Europe for sounding balloons and would be made in the Simla workshop at a cost of about R12 for each outfit.

It would be attached to two balloons of which one would be arranged to collapse or detach itself at the maximum height required. When this occurred the second balloon would be pulled down by the weight of the apparatus, and on the latter reaching the ground would, except in strong winds, remain in the air above it at the end of a long cord and mark its position. The self-recording apparatus would register variations of pressure, temperature and humidity continuously during the ascent and descent.

4. If the scheme is approved it will be necessary to secure the co-operation of the Deputy Commissioners of the districts in which balloons are likely to descend in advertising our intentions among headmen of villages. In the case of the experiments in May such districts would be those lying round and within 25 miles of the starting point, in all

directions, but for the work in July, September and December the area where descent is likely would extend for 200 miles and be confined to the quadrant between north-east and south-east of the starting point.

5. Varnished labels attached to the instruments would explain in several languages what was to be done with the balloons, and inform the finder that a reward of R5 would be paid to him by the department provided that he followed the instructions. The finder would inform the nearest Revenue or Police officer and through him a telegram would be sent to us at the starting point, when our own messenger would be sent to bring back the balloons and pay the reward. My estimate of the additional expenditure to be met from my funds for the whole work proposed for 1908 would be R1,500.

6. With regard to the matter raised in paragraph 5 of the Committee's note the solar observations now in progress in different countries fall into three classes:—(*a*) eye observations and photographs of the sun's surface, for the study of spots and other abnormalities, (*b*) spectroscopic observations (by eye and spectro-heliograph) showing the distribution and behaviour of the heated gases, and (*c*) examination of heat given out by the sun. The last two have been developed to a far greater extent in America than elsewhere: in fact the only complete apparatus for (*c*) in the world is there. At Kodaikanal we carry out (*a*) and (*b*), but disregarding entirely untrustworthy instruments, there are no regular measurements at present possible in India of the heat given out by the sun except some of a limited kind by means of the Angström pyrheliometers at Simla and Kodaikanal.

7. It is well established that the winds on the earth's surface as well as evaporation and the formation of cloud are directly due to the heat of the sun; and as we know that the solar activity (as evinced by sunspots) changes considerably from year to year it seems probable that the heat given out should exhibit corresponding variations and there should be consequent changes in the amount of rainfall and the strength of such currents as the monsoon. Recent investigations indicate that the black-bulb thermometers formerly used in India for the measurement of radiation are inadequate and that our present equipment for solar work in India is therefore somewhat ill balanced in that we keep up a really good observatory for examining the sun from certain standpoints, but have no apparatus which I should call first class in place of black-bulb thermometers for examining those solar changes which have most to do with the monsoon and the general well-being of the country.

8. When I was in America I incidentally saw Professor Langley and his bolometer which was by far the best instrument of its kind in existence; I had not time however to acquire more than general ideas on the subject. At the earliest opportunity I started in India the use of the Angström pyrheliometers, probably the best instruments apart from the American ones; but these give only a small part of the information obtainable by the latter, and being liable to change, require from time to time comparison with a standard instrument, a somewhat difficult task for which we have no equipment. The complete outfit in accordance with American methods, which have been improved by Langley's successor Mr. C. G. Abbot, would probably cost £2,000 to £3,000; but correspondence with Mr. Abbot has shown that an instrument suitable for our purpose and giving much more information than the Angström pyrheliometers could be made for a comparatively small sum and I should not expect to find it necessary to recommend spending more than £150 upon it.

9. When Mr. Field went on leave six months ago, I endeavoured to arrange that he, who is exceptionally clever in devising and making apparatus and is keenly interested in solar radiation, should be sent to America to learn their methods and discuss with Mr. Abbott an instrument to be set up at Kodaikanal. The knowledge of means of standardising which he would have acquired would have been invaluable in enabling us to compare our present Angström pyrheliometers with a standard instrument, and so to correct for the changes which would from time to time occur in them. My effort was unsuccessful, and the Observatories Committee are now urging the department to a large increase of activity in this direction.

10. It would appear that the variations in the amount of solar radiation which we are to study can only be investigated by means of observations extending over a series of years; and it may perhaps be inferred that the Committee in recommending continuous observations at a high altitude for twelve months intended that information should thereby be gained as to the best method of carrying on the observations on a reduced scale in future years. To this proposal it must unhappily be replied that it would be quite impossible without crippling the work of the department to spare Mr. Field or either of the other two gazetted assistants to remain for the whole of a year in a place at a high altitude where he would be unable to take part in the ordinary work at headquarters. Further we have not the equipment for the purpose.

11. It does not seem advisable to ask for an additional appointment of a gazetted officer for measuring solar radiation and it seems inevitable that the work should be undertaken at Kodaikanal by the present staff who are accustomed to dealing with optical problems and have many instrumental facilities.

12. With regard to the equipment an Angström pyrheliometer has recently been provided at Kodaikanal and Dr. Schuster suggested the use in conjunction with it of such a coloured screen as has been recommended by Angström for cutting out those portions of the radiation which are mostly affected by terrestrial absorption. It was also proposed by Mr. Evershed to eliminate the disturbing effects of absorption by the earth's atmosphere by making a series of comparisons of the brightness of the moon or of Jupiter with that of Sirius or some other bright star, the bodies being compared on the same night and at the same altitude. Variations of the solar radiation would affect the light of the moon and of Jupiter and if the variations were found to be the same whichever star was chosen for reference they might be assumed to be real.

13. It would appear desirable to supplement this work by a spectro-bolometric examination of the sun's radiation in order to ascertain which parts of the spectrum are chiefly affected by the atmosphere and to trace the variations of those parts which are least affected. In the absence of information gained by a personal visit we shall have to rely upon correspondence and many of the details will have to be worked out afresh with a considerable expenditure of valuable time. From the scientific standpoint, however, there is some compensating advantage in this duplication in that a largely independent investigation will be secured.

It must be admitted that the atmospheric conditions at Kodaikanal at 7,700 feet are probably not so good as at some less accessible station at a much greater altitude in the Himalayas, but the facilities available at our existing observatory make up for this, and it is the only place at which the experimental difficulties could without great outlay be overcome by our present departmental staff.

3.—Survey of India (Scientific Research Work).

Gravimetric Survey.—Pendulum observations will be taken on the Aravalli and Vindhya mountains. Observations of the plumb-line will be taken south of the Nepal Himalaya.

Magnetic Survey.—Colaba Observatory under the Meteorological Reporter and the four observatories under the Surveyor-General will continue to work. Observations will be taken at 24 Repeat stations and the preliminary survey will be completed.

Solar Photography.—Photographs of the sun will be taken daily at 10 A.M. and 4 P.M. at Dehra-Dun, as has been done since 1879 in conjunction with Greenwich.

Himalayan Geography and Geology.—In conjunction with the Geological Survey, the Survey of India will publish a paper summarising the present position of Himalayan Geography and Geology. (Unforeseen delays have occurred in the publication of this paper.)

Standard of length.—A new standard of length will be procured for the Survey of India. The old standard has been sent to Breteuil for comparison against the international metre.

4. Geological Survey.

PART A.—*Subjects undertaken during 1907-08 to be continued.*

(1) Mapping of unsurveyed areas in the Shan States.
(2) Continued survey of the tin deposits in South Burma, with general geological survey of the areas in which they occur.
(3) Survey of the oil-bearing regions in the Irrawaddy valley and in the Arakan districts.
(4) Survey of the volcano of Popa in the Myingyan district of Upper Burma.
(5) Examination of the material collected from the copper-bearing belt in Singhbhum, and associated Dharwarian and gneissose rocks.
(6) Annual inspection of manganese mines in the Central Provinces.
(7) Extension of the geological map over unsurveyed areas in the Chanda, Raipur and Drug districts.
(8) Extension of geological map over previously unsurveyed areas in Central India and the neighbouring States of Rajputana.
(9) Chemical work on brines and salt samples from Rajputana.
(10) Palæontology of (*a*) the Liassic rocks of Baluchistan, (*b*) the Lower Tertiary marine beds of Baluchistan, and (*c*) the Cambrian, Ordovician and Silurian rocks of Spiti.

PART B.—*New Questions.*

(11) Mapping of previously unsurveyed areas in the Amherst district of Lower Burma.

(12) Revision of the geological map of the Raniganj coalfield in conjunction with a Committee appointed by the Mining and Geological Institute of India.

(13) Survey of the ossiferous deposits of the Siwaliks and the Salt Range.

(14) Examination of copper-ore and associated sulphide-ore deposits in Sikkim.

(15) Survey of certain glaciers in Sikkim.

(16) Palæontology of (*a*) Cretaceous rocks of Tibet, (*b*) Fossil fishes of the East Coast Gondwanas.

5. Botanical Survey.

I.—Country under the Superintendent of the Royal Botanic Garden, Calcutta :—

(*a*) **Bengal.**—An endeavour will be made to make a representative collection of the plants found in one or more of the districts of Bengal to be utilized, it is hoped, ultimately in the preparation of District lists.

(*b*) **Assam and Burma.**—The same policy will be pursued as far as possible within Assam and Burma.

II.—Survey of Bombay. No programme has been submitted.

III.—Survey of Southern India. The Government Botanist, Madras, proposes during the year 1908-09 to explore the flora of the Nilgiris and the Anamalais from April to June and the Enamalais and Nallamalais during July—September.

IV.—Survey of Northern India. No programme has been submitted.

6. Agricultural Departments.

I.—GENERAL.

The Inspector-General of Agriculture has promised from his grant for Agricultural Experiments substantial assistance (*a*) for enquiries regard-

ing Reh in Sind, (*b*) for a threshing machine trial in the Punjab, (*c*) for the flax fibre industry which in parts of India is likely to succeed, (*d*) for the distribution of selected seed of various important crops, (*e*) for the testing of certain agricultural methods, implements and manures which are likely to be economically introduced in some districts, (*f*) for improving the scope of poultry breeding, (*g*) for testing bee-keeping as a minor agricultural industry.

2. In addition to the general field work at Pusa which is now very varied, lac has been there introduced as there is a large field for lac culture on existing trees in Behar.

3. The cultivation of eri silk is being tested as likely to be a useful minor agricultural industry in some districts where the castor oil plant is commonly grown. At Pusa it will be determined, amongst other questions, whether the worms will survive the dry hot weather or can be acclimatized to it.

4. A big enquiry has been started which will deal with the natural fodder plants of India, their distribution and feeding value.

5. The Research Institute will be ready for occupation at latest in June 1908. The apparatus and records of each section will be transferred before that date from the temporary laboratories to the new buildings. Distinguished graduates of the Provincial Agricultural Colleges, or distinguished science students from Indian Universities, will be admitted for a two years' course. Each will specialize in a particular branch of Agricultural Research. The majority of these students will be helped by fairly liberal scholarships. The facilities at Pusa for the post-graduate teaching of Indian agricultural students will, when the Institute is opened, be of the very highest standard.

II.—Agricultural Chemistry.

1. *Available plant food in soils.*—This subject has been referred to in previous programmes. The work during the past year has been on the lines already indicated, but in addition to work at Pusa field experiments on the value of superphosphate are being conducted at a number of centres in Behar, that is, the laboratory results are being tested in the field. Whilst this work is yielding useful information, it must be fully recognised how empirical are our methods, and the laboratory work at Pusa is now being directed to a more thorough

examination of the precise state of the compounds in the soil, the phosphates forming the first main objective. The more exact relationship of the carbonic acid gas in the soil to plant foods forms another part of the same subject.

2. *Water in soils.*—This subject divides itself under two heads, namely, drainage and evaporation. The four gauges at Pusa are providing interesting data regarding the former, which are supplemented by those at Cawnpore. In addition to the gross amount of water passing away, data are being collected regarding the rate of percolation and the nature and amount of dissolved substances which are carried with the drainage water.

The records of evaporation which are being maintained have so far led to two important conclusions, the one being that dry weather water rises in the soil from a limited depth only, the other that the rate of loss depends (among other things) on the amount of water present. There is some hope, too, that the true relation between the physical properties of a soil and its power to retain water may be rendered clearer than it is at the present day. An account of the first year's work is in the press.

A knowledge of the amount of water in a soil is, however, only one factor of a larger subject, for it is equally important to know how much water crops require. Tentative experiments are in progress on this part of the subject. The data which have been published in Europe and America are not only divergent among themselves, but would not, without verification, be applicable to Indian conditions. It is obvious that a more exact knowledge of the movement of water in soil will at the same time yield information as to the movements of dissolved substances, whether these are valuable plant foods or deleterious salts; at present this subject is chiefly characterised by its nebulous state.

3. The chemical investigations connected with the permanent field experiments at Pusa will be commenced.

4. *Cyanogenetic glucosides.*—It was explained in the last programme that the work on this subject is restricted at Pusa to the ascertainment of the conditions under which these compounds are formed in large quantity in the plant. At present it can only be said that the work is in progress. Some positive results were obtained last year with jowar (*Andropogon Sorghum*), but it would be premature to publish them at present. This investigation will rank as of second importance.

III.—Economic Botany.

1. *Plant breeding and plant improvement.*—During 1908 wheat, tobacco, cotton and barley will be especially studied, but attention will be given to other important crops grown in Behar. The determination of the varieties of Indian wheat, tobacco and barley will be continued.

2. *Fibre plants.*—The collection and investigation of fibre-yielding plants will be continued.

3. *Fruit experiments.*—The permanent experiments on the culture of Indian fruits will be continued on the lines laid down in the first report.

4. *Minor investigations.*—The study of Cassava as a famine food stuff. The economic importance of the male plants in Ganja cultivation.

5. *Publications.*—The monograph on Indian wheat will be completed.

IV.—Mycology.

1. *Training.*—The training of probationers for posts of Mycological Assistants in the provinces will be continued.

2. *Research and experimental work.*—The amount of pathological work of pressing importance which has arisen during the past year has led to the temporary abandonment of the work on soil *Fungi*, referred to in the last programme.

3. The following will be the chief lines of investigation :—

(*a*) *Diseases of indigo.*—The introduction of the Java Natal variety of this plant has led to severe outbreaks of disease. Its successful cultivation at the present moment centres on the checking of these diseases. They have not, however, been previously studied, and much investigational work is needed before even their causes can be determined.

(*b*) *Wilt diseases of cotton, gram and pigeon pea.*—The prolonged investigation into the wilt diseases of cotton, gram and pigeon pea which has not yet determined successful treatment will be continued. The investigation of other wilt diseases which are known now to affect Indian crops has been taken up.

(*c*) *Diseases of Citrus fruits.*—A number of these have been recently reported and are under study. The results will probably be ready for publication during the year.

(*d*) *Palm diseases.*—The biologic study of the parasite of bud rot is practically completed. Assistance will continue to be given in the operations to check this disease in the Godavari delta.

(*e*) *Sugarcane diseases.*—Field experiments with red-rot and smut will be continued.

(*f*) The identification and study of other crop diseases will continue as usual.

4. *Systematic work.*—The identification and recording of the species *of Fungi* collected in India will be continued with assistance from abroad. Three of the main groups have been finished up to date from the Pusa collections. The largest, however, remain.

5. A commencement has been made in preparing a text-book of Indian crop diseases, and it is hoped to complete this.

V.—ENTOMOLOGY; PART I.

1. Special attention will be paid to insects injurious to indigo, to the problem of controlling surface grasshoppers and to pests of rice.

2. Assistance will be given in directing the work of Provincial Assistants and in coping with any large outbreaks of pests that may occur. The extent to which Provincial Departments of Agriculture will require assistance cannot be estimated at present.

3. The enquiries into insecticides non-poisonous to cattle and regarding the experimental cultivation of lac and of eri and other wild silks will be continued.

4. The transfer and arrangement of collections and records to the main laboratory will occupy considerable time.

5. The teaching of Entomology to advanced students will entail the preparation of a syllabus.

6. Simple leaflets to explain coloured plates illustrating the life history of common injurious insects will be prepared, if necessary, for any province. Economic work in dealing with such insects will be developed as far as possible, and, if necessary, other work will be dropped to give time for this.

7. The study of insect-eating birds will be continued by the Supernumerary Entomologist.

8. Further enquiry will be made into fumigation methods for treating grain and plants.

9. Methods of checking white ants will be further studied.

10. A month's course of elementary Entomology will be given at Nagpur by the First Assistant.

PART II.

1. The investigation of the biting flies of India will be extended. The distribution and breeding habits of the various species will be especially studied, as being most likely to afford information of value in connection with the spread of disease.

2. Dipterous pests of crops will be studied.

3. The sorting and arrangement of collection of Diptera will be undertaken, and the species identified, wherever possible.

4. The care and maintenance of the general collection will be taken over by the Second Entomologist.

5. The Second Entomologist will help in the preparation of the text and illustrations of the book of Indian insects.

VI.—AGRICULTURAL BACTERIOLOGY.

One or more of the following problems will be attacked :—

I.—The chief bacteria characteristic of Indian soils, particularly those taking part in—

(*a*) The fixation of nitrogen.

(*b*) The rotting of organic material.

(*c*) Nitrification.

II.—The characteristic organisms growing in association with leguminous crops in India, with particular regard to the inoculation of the soils growing them.

III.—The bacteria taking part in the rotting of stored organic material under Indian conditions and the bearing of the knowledge gained on the conservation of cattle manure in India.

IV.—The fermentation processes taking place accompanying the manufacture of silage in India.

V.—The fermentation processes taking place during the manufacture of tobacco.

VI.—The fermentation processes taking place during the manufacture of indigo.

VII.—Any bacterial diseases of important Indian crops.

VII.—AGRICULTURE.

1. *Permanent manurial experiments.*—These are described in detail in Series I below.

2. *Permanent rotation experiments.*—These are described in detail in Series II below.

3. *Permanent pasture experiments.*—These will be continued according to the scheme appended. These experiments are not considered of the first order.

4. *Sugarcane.*—Work on sugarcane will include (i) trials of varieties, (ii) methods of planting, (iii) methods of manuring, (iv) selection of superior sorts or other selection. The sugarcane work is not considered of the first order.

5. *Flax and other fibre crops.*—The possibility of establishing a flax industry in this country will be further investigated. Experiments on the cultivation and preparation of flax will be conducted on a larger scale than hitherto. In view of opinions given by the flax expert, the crop will not occupy at Pusa the same land oftener than once in four years and will be grown in rotation with indigo and other important Behar crops. The work will include plant selection in the crops which are dealt with. Sunn-Hemp (*Crotalaria juncea*), *Sida rhombifolia*, *Hibiscus cannabinus*, *Hibiscus panduriformis* and *Malachra capitata* will be tested on a field scale.

6. *Tobacco.*—A fairly large area of selected indigenous and exotic varieties will be grown, and experimental work in curing will be done in the curing house.

7. *Varieties.*—Varieties tested will include those of wheat, rice, maize, opium and castor. Plant to plant selection will be carried out wherever possible.

8. *Threshing trials.*—These will be continued on the same lines as last year with special reference to wheat.

9. *Breeding.*—The breeding of bulls for the province of Bengal will be continued. A Dumbha ram has been purchased and will be used with selected ewes. Poultry breeding will be carried on with selected imported and indigenous breeds. In connection with the cross-breeding of sheep and poultry, Mendel's Laws will come under study.

10. The general improvement of the estate will be continued.

Note by the Imperial Agriculturist on the permanent experiments at Pusa.

The problem of agriculture is to secure from the soil the maximum production possible under the existing conditions and with the resources at the command of the cultivator. Next to climate, the most important factor in production is the degree of fertility of the soil; fertility is conditioned by circumstances which are still far from being properly understood. While in a large measure it is a quality inherent in the soil it may be profoundly modified by agricultural practice with respect to cultivation, manuring and rotation of crops. The proposed permanent experiments detailed below have been arranged with a view to study the conditions which determine soil fertility in a sub-tropical climate, and in particular the manner in which soil fertility is affected by the application of the more important manures, including green manure, by rotation of crops (with special reference to the part played by legumes in a rotation) and by tillage.

Permanent Pasture Experiments.

Manurial Scheme for Pasture Experiment.

No.	Details.	Remarks.
1	No manure.	To be applied once; thereafter at the end of three years or other date to be subsequently fixed to be followed by 10 tons farm yard manure repeated every fifth year.
2	Superphosphate=150 lbs. Phosphoric acid per acre.	
3	Basic slag=150 lbs. Phosphoric acid per acre.	
4	Superphosphate=100 lbs. Phosphoric acid per acre.	
5	Superphosphate=100 lbs. Phosphoric acid per acre. Sulphate of potash=50 lbs. Potash per acre.	

No.	Details.	Remarks.
6	Rape Cake=100 lbs. Nitrogen.	To be applied every fifth year.
7	Castor Cake=100 lbs. Nitrogen.	
8	Ammonium sulphate=20 lbs. Nitrogen per acre.	
9	Nitrate of Soda=20 lbs. Nitrogen per acre.	
10	Superphosphate=25 lbs. Phosphoric acid per acre.	
11	Superphosphate=25 lbs. Phosphoric acid per acre. Sulphate of potash=20 lbs. of Potash per acre.	
12	Superphosphate=25 lbs. of Phosphoric acid per acre. Ammonium Sulphate=20 lbs. of Nitrogen per acre.	To be applied every year.
13	Superphosphate=25 lbs. of Phosphoric acid per acre. Ammonium Sulphate=20 lbs. Nitrogen per acre. Sulphate of Potash=20 lbs. Potash per acre.	
14	Farm-yard manure 3 tons per acre.	

The extent of even land available in the pasture land at Pusa is limited and the proposed experimental plots are therefore smaller than is desirable. The area in one block will be divided into 14 plots each of one acre. One-fourth of each plot will be fenced off and cut annually as hay, the remaining three-fourths will be grazed by cattle and simply kept under observation.

A detailed botanical examination of the character of the herbage of each plot will be undertaken.

SERIES I.

Permanent Manurial Experiments.

The object of this series is to determine the specific effect on soil fertility of the more important organic and chemical manures applied alone and in various combinations to a two years' four-course rotation.

Kharif.	Rabi.	Kharif.	Rabi.	Manures applied per acre.
1. Maize	Rahar.	Maize.	Oats .	No manure.
2. Maize	Rahar	Maize.	Oats .	Farm-yard manure to supply 10 lbs. Nitrogen.
3. Maize	Rahar	Maize.	Oats .	Farm-yard manure to supply 20 lbs. Nitrogen.
4. Maize	Rahar	Maize.	Oats .	Farm-yard manure to supply 30 lbs. Nitrogen.
5. Maize	Rahar.	Maize	Oats .	Rape cake to supply 20 lbs. Nitrogen.
6. Maize	Rahar.	Maize.	Oats .	Sulphate of Ammonia to supply 20 lbs. Nitrogen.
7. Maize	Rahar.	Maize.	Oats .	Sulphate of Potash to supply Potash as in Farm-yard manure No. 3.
8. Maize	Rahar.	Maize.	Oats .	Superphosphate to supply Phosphoric acid as in Farm-yard manure No. 3.
9. Maize	Rahar.	Maize.	Oats .	Sulphate of Potash to supply Potash. Superphosphate to supply Phosphoric acid. } As in Farm-yard manure No. 3.
10. Maize	Rahar.	Maize.	Oats .	Sulphate of Ammonia to supply Nitrogen. Sulphate of Potash to supply Potash. Superphosphate to supply Phosphoric acid. } As in Farm-yard manure No. 3.

Plots to be ¼ acre duplicated, and all the crops of each rotation to be grown in the same year. Manures to go on every year on the Maize.

SERIES II.

Permanent Rotation Experiments.

This series is designed to determine how far soil fertility is affected by growing in a rotation leguminous crops (1) removed from the land, (2) returned to the land in the shape of green manures. It is complementary to Series I, inasmuch as the results obtained will give an indication of how far legumes can replace manures in a rotation.

Kharif.	Rabi.	Kharif.	Rabi.	Manures applied per acre.
Maize .	Barley	Maize.	Oats .	No manure.
Maize .	Barley	Sunn .	Oats .	Green manure on cereal rotation.
Maize	Rahar.	Maize.	Oats .	Residual value of deep-rooted pulse.
Maize .	Rahar.	Maize.	Oats and peas.	Residual values of two legumes one deep and one shallow rooted.
Maize .	Rahar.	Sunn Hemp	Oats .	Residual value of a pulse crop plus a green manure.

Plots to be ¼ acre duplicated, all the crops of each rotation to be grown in the same year.

Provincial Departments of Agriculture.—The programmes for next year generally follow those described in last year's programme placed before the Board of Scientific Advice. The following are, however, important additions:—

Bengal.—An area of 210 acres has been acquired for a Government Farm at Chinsura in the Hooghly district. The land is representative of the deltaic tracts of the province.

Experimental work will be commenced on the newly opened farms at Bankipur and Sabour. Well boring experiments will be undertaken. Proposals have been made for the improvement of sericulture.

United Provinces.—At Cawnpore several new investigations will be taken up. They include the trial of cotton refuse as manure, the methods of preserving potatoes and fruits, and the renewal of seed stocks of potatoes in the hills. Preliminary experiments with a view to

study of losses in sugar manufacture will be undertaken by the Agricultural Chemist. Mr. Hadi, the Assistant Director, has been deputed on special duty to organise sugar manufactories according to his methods of manufacture. Information concerning the agaves of the provinces will be collected by the Economic Botanist. . . . .

Punjab.—The equipment of the Lyallpur College and the framing of the curriculum and prospectus will be undertaken. A second experimental farm will be opened for preliminary investigations with regard to diseases of gram, the question of fodder scarcity, improvement of tillage, study of crop rotations and other experiments. Preliminary observations on the effect of light and heavy waterings and surface cultivation on different crops and soils will be made with a view to restarting irrigation experiments. Other experiments include the trials of machinery and the inoculation of land newly sown with leguminous crops. The Agricultural Chemist, when his chemical laboratory is ready, will start on investigations regarding the Punjab alkali lands, the water of salt wells in the Southern Punjab and the improvement of sugar manufacture. The Economic Botanist will undertake a survey of the indigenous cottons of the Punjab and the North-West Frontier Province.

Bombay.—Experiments will be initiated in the manuring of the pasture lands. At Daulatpur in Sind, experiments will be made to reclaim the worse kind or alkali or kalar lands.

Madras.—Paddy experiments will be carried out at the Samalkota, Palur and Coimbatore stations with numerous objects in view. Cotton experiments will be conducted on a larger scale than last year. Indigo will be tried as a rotation crop with cotton. An enquiry will be made into the fodder plants of the chief grazing districts of the Presidency. The Agricultural Chemist will start an investigation regarding the agricultural value of the tank and river silts of the Presidency.

Burma.—Experimental work will be commenced on the newly formed farms at Mandalay and Hmawbi. Cotton, paddy, groundnut, jute, sugarcane and other crops will be tried on these farms. Rotation and manurial experiments will also be undertaken. Attempts will be made to introduce better implements. A survey of the agricultural conditions of the province will be started. The Agricultural Chemist will take up the examination of the soils of the experimental farms and of some saline lands.

Eastern Bengal and Assam.—A considerable number of new crops will be tried including American potatoes and groundnut. Improved

poultry breeding will be attempted. Sericulture will be promoted by supplementing pure seed stations with the large rearing stations.

7. Forest Department.

The following are some of the various investigations which will be made with the assistance of other officers of the Department :—

I.—WORKING-PLANS.

1. The compilation from selected Working-Plans of data regarding the rate of growth of different species (ring countings, sample plots) and generally the tabulating, in convenient form, of statistics and information regarding different species, methods of working, etc., now scattered throughout the plans. A statement showing sanctioned Working-Plans, with area of forest, period of plan, method of treatment and principal species has already been compiled as a basis of this and other investigations.

2. With regard to normal stock, selected areas containing what appears to be a full stock of I, II, III and other classes will be counted out, and the average of each class taken as an approximate normal, as a preliminary to the more accurate investigation of this subject. The following species will be first taken in hand—Sâl, Teak, Deodar, *Pinus longifolia*, *Pinus excelsa*, and as soon as possible other species now being worked under Working-Plans.

3. A careful study of the selection system will be made. The following points merit attention in this regard in order to discover the best means of working by compartments so as most nearly to approach the ideal method of working over the entire area annually for the removal of mature trees, *e.g.*,—

(*i*) By making the annual coupes as large as possible so that the area may be worked over at as frequent intervals as possible.

(*ii*) By fixing such an exploitable girth that the loss of interest due to leaving mature trees standing for an excessive period is reduced.

(*iii*) By allotting gradually decreasing areas for the annual coupes.

4. The examination of control of forms in order to ascertain the average outturn by different methods of working in force, and generally to collect and collate the statistics of the results of forest management

throughout India which are included in past control forms will be continued.

5. The compilation of a list of terms to be used in all Working-Plans, the meanings of the terms used being given and the list officially circulated and prescribed for future use will be completed.

6. Preparation for teak of a paper setting forth all that is known regarding habits, methods of treatment, etc., such as has already been prepared for the sâl.

II.—Sylviculture.

7. A practical examination will be made into the effects of fire on grazing areas in order to ascertain—

(*i*) Whether the grass on areas burned over annually decreases in quantity and quality;

(*ii*) Whether this result or the reverse happens in the case of areas protected from fire, and especially whether protection from fire encourages the growth of coarser grasses, or leads to the replacement of coarse grasses by others more suitable for fodder.

8. The effects of fire conservancy of different species in various conditions of climate and growth, more especially on sâl and teak will be studied.

9. An examination into the conditions favourable to the replacement of the selection method by the regular method will be commenced.

10. The effects of soil composition and underlying rock on the distribution and growth of different species will be investigated.

11. The effects of the continuance of a given species (*e.g.*, sâl, teak) as regards the soil fertility for that species will be enquired into.

III.—Forest Zoology.

12. Investigation in the United Provinces into the distribution and life histories of the *Monophlebus* scale insect, *Sphærotrypes Siwalikensis*, and the sâl defoliators in the submontane sâl areas of the Ganges, Garhwal, Kumaun and Naini Tal Divisions, and into the *Pinus longifolia*, *Cryptorrhynchid* weevil, *Tomicus* and *Polygraphus* bark-borers and

Platypus wood-borer in the Chir areas of Garhwal, Kumaun and Naini Tal Divisions will be continued.

13. Investigation in the Punjab into the distribution and life histories of the following insects in the hill coniferous forests of the Kangra Division:—

The *Scolytus* pests of the deodar and the *Polygraphus Pityepenes*, *Platypodæ* and cone-borers and defoliators of the *Pinus excelsa*, Spruce and Silver Fir: also the defoliating and wood-boring pests of the hill oaks and pests of *Pinus longifolia* will be carried on.

IV.—Forest Economy.

14. The enquiry into the utilization of the less valuable kinds of timber as railway sleepers will be continued and a practical experiment will be made with sleepers obtained from *Dipterocarpus* sp. from Burma and the Andamans.

15. Seeds of the more important indigenous species will be collected and sent for experimental cultivation to various British colonies and Foreign countries.

16. Enquiry will continue into the subject of—

(*a*) Woods suitable for the manufacture of matches.
(*b*) Cultivation of lac.
(*c*) Antiseptic treatment of timber, particularly for railway sleepers.
(*d*) Utilization of various oil seeds from forest trees.
(*e*) Timbers at present little known which it is desired to bring to notice.
(*f*) Utilization of *Xylia dolabriformis* waste for paving blocks.
(*g*) Woods for lead pencils.
(*h*) Woods for cricket bats.
(*i*) Yew wood for archery.
(*j*) Woods for tea boxes.
(*k*) Camphor from *Blumea balsamifera*.
(*l*) Cultivation of *Podophyllum*.
(*m*) Cutch.
(*n*) Destructive distillation of wood.
(*o*) Walnut "Burrs."
(*p*) Rubber cultivation.

V.—Forest Botany.

17. The following subjects will receive attention :—

(*a*) Study of the coppicing of teak, its effect on the normal health and development of the tree.

(*b*) The grasses of Savannah tracts in Bengal will be examined with special reference to their difference in burnt and unburnt areas.

(*c*) A study will be made of the timber of different species of Tun and *Grewia*, to ascertain which yield the most valuable wood.

(*d*) Investigation (in the Madras Presidency) into the subject of the rising of marks on tree stems, used to indicate fixed levels of measurement in sample trees or plots.

VI.—Forest Chemistry.

18. Further examination of tannin extracts will be made.

19. The collection and analysis of the latices of rubber-producing species will be continued.

20. The following subjects will be worked at—

(*a*) The analysis of oil seeds for their oil values and oil oaks utilization.

(*b*) The analysis of resin and lac.

(*c*) Experiments with the newly designed camphor still and the distillation of camphor from *Blumea balsamifera* of Burma.

(*d*) Investigation in Burma into the various species of Compositæ as to their suitability for the production of camphor or any other valuable essential oil.

(*e*) Investigations into the active principles of the Nim tree (*Melia indica*).

(*f*) Investigation into Catechu with a view to prepare Catechin-free Cutch on a commercial scale will be continued.

(*g*) Investigation into the manurial value of the various leaves, twigs and shrubs indigenous in the Madras Presidency, in order to ascertain the proportion of nitrogen and phosphoric acid, etc., which they contain.

VII.—General.

21. Pamphlets, circulars, as well as the Memoirs and Records of the Forest Department, setting forth the results of investigations into various

subjects affecting the progress of Indian Forestry, will be published from time to time.

8. Natural History Section, Indian Museum.

The Superintendent, with the aid of specialists in Europe, will continue his work on the fauna of fresh and brackish water in India and on the distribution of the reptiles and insects of the Himalayas. Captain R. E. Lloyd, I.M.S., will continue the survey of the house rats of India commenced in the Museum since last year's programme was submitted, while the special temporary assistant will arrange the old collection of mammals and work at new material representing groups other than Muridæ. Captain F. H. Stewart, I.M.S., Surgeon-Naturalist on the "Investigator," will, while in Calcutta, work at the Museum collection of Polychætes, while Captain Lloyd investigates in his spare time the unidentified deep-sea fish. The late Superintendent, Lieutenant-Colonel A. W. Alcock, will continue his "Catalogue of the Decapod Crustacea," collections being sent him to Europe, while other specialists in Europe and America will work at the collections of other groups which have already been or will shortly be despatched from Calcutta. Special attention will be devoted in the Entomological laboratory to the Diptera of India, at which Mr. E. Brunetti will continue to work, and to the insects of Calcutta and the neighbourhood, regarding which it is proposed to commence the compilation of a local "fauna" during the year.

9. Civil Veterinary Department.

By the Laboratory Staff:—

(1) **Anthrax.**—An investigation into the methods and practical value of immunization by means of bacterial products in order to obtain a single and efficient vaccine suitable to the conditions of the country.

(2) **Hæmorrhagic Septicæmia.**—Investigations into methods of immunization against the disease.

(3) **Trypanosomiasis.**—To continue investigations on the lines laid down in the programme of previous year.

By the Officer investigating camel diseases:—

The Officer investigating camel diseases will continue the investigations into Surra in the field. He will establish temporary

head-quarters for the purpose during the summer and rains and endeavour to ascertain the causal agents of transmission and the natural history of the disease.

By the provincial staff :—

Collection of information and the mapping out, as opportunity occurs, of the incidence of Surra, Piroplasmosis, Hæmorrhagic Septicæmia and Anthrax.

APPENDIX.

APPENDIX.

ECONOMIC INVESTIGATIONS CONDUCTED FOR INDIA AT THE IMPERIAL INSTITUTE DURING THE YEAR ENDED THE 30th SEPTEMBER 1908.

BY

W. R. DUNSTAN, M.A., LL.D., F.R.S.,

Director of the Imperial Institute.

The following are the principal investigations relating to the composition and economic value of Indian products dealt with in the Scientific and Technical Department of the Imperial Institute during the year.

DRUGS.

Aconites.—The investigation of the various Indian aconites has been continued with the new material supplied by the Officiating Reporter on Economic Products, but the work has been delayed somewhat in order that special attention might be given to expediting the work on solanaceous plants referred to below.

Solanaceous Plants.—Estimations of the total alkaloids present in the Datura and Hyoscyamus plants received have now been made and the work of determining the amount and nature of each of the various alkaloids present is in a fairly advanced stage.

Strychnos species.—The seeds of *Strychnos potatorum* are under investigation in connection with this enquiry.

Opium.—The working plant for the extraction of alkaloids from opium by the new process devised at the Imperial Institute, referred to in last year's report as under construction for the Opium Factory at Ghazipur, has now been despatched.

Thalictrum foliolosum.—The roots of this plant are being investigated at the suggestion of the Imperial Institute by Professor W. H. Perkin, F.R.S.

RUBBER.

Four samples of rubber were reported on during the year, three being specimens of *Ficus elastica* rubber and the fourth Ceara rubber.

Two of the Ficus rubbers came from Mukkie in the Kanoth range, North Malabar, and were in the form of 'Scrap' and 'biscuits' respectively. The former contained 28·1 per cent. of resin and was valued at 2*s.* 11*d.* per lb.; the biscuits, although containing less resin (23·6 per cent.) than the scrap were very dark coloured and were consequently valued at only 2*s.* 5*d.* per lb. The third specimen of Ficus rubber was collected by natives in Northern Arakan during 1904-05. It was highly impure and was not suitable for analysis or valuation.

The Ceara rubber was from South Arcot, Madras. It was of very fair quality and was valued at 2*s.* 5*d.* per lb. At the time of all the above valuations fine hard Para rubber was quoted at 3*s.* 5½*d.* per lb.

A collection of Para, Ceara and Castilloa rubbers from the Nilgiri Hills, forwarded by the Agri-Horticultural Society at Teynampett, was under investigation at the end of the year.

FIBRES.

Cotton.—Five samples of cotton, grown in the Myingyan district, Burma, were examined. These consisted of American Upland cottons, and although of very promising quality on the whole, they were somewhat inferior to similar cotton grown in the United States, since they were stained and partly immature. It was suggested that greater care should be exercised in cultivation and that measures should be taken to prevent damage by insect pests. The samples were valued at 6*d.*-6½*d.* with "middling" American at 6·63*d.* per lb.

A sample of "kidney" tree-cotton, grown at Sambalpur, was of good quality, and would probably find a market as a rough, long-stapled cotton of Peruvian character. It was valued at 9*d.* per lb. with "good fair" moderately rough Peruvian at 9¼*d.* per lb.

A boll of a wild cotton plant from Tenasserim, Burma, was examined. The lint was of excellent quality, resembling that of short-stapled Indian cotton, and was regarded as worth about 5½*d.*-6*d.* per lb., with "fine" machine-ginned broach at 5 $\frac{5}{16}$*d.* per lb.

Information was supplied to a London firm with reference to the yield of lint obtainable from Caravonica seed cotton.

Agave and Furcræa Fibres.—Three samples of fibre grown at the Hindupur Fibre Firm in the Anantapur district of the Madras Presidency were examined. The fibre of *Agave rigida* was of excellent quality and worth £36 to £38 per ton with Mexican sisal at £34 per ton. The

specimen of *Agave Americana* fibre was rather short and of uneven quality, part of it being white, lustrous and fairly well cleaned, while the remainder was gummy and had a small quantity of greenish leaf pulp adhering to it. The fibre of *Furcræa* sp. was rather short, somewhat uneven in colour and not very carefully prepared. It was considered to be worth £26 to £27 per ton, with Mauritius hemp at £24 to £30 per ton.

Two samples of Agave fibre from Assam were of good strength, but not well cleaned. If properly prepared and not less than four feet long, the fibre would have been worth about £30 per ton.

Sida rhombifolia.—A specimen of *Sida rhombifolia* fibre from Bengal was fine, silky, well-prepared, of fair strength, and compared favourably in chemical composition and behaviour with "extra fine" Indian jute. It was stated that it could probably be used for mixing with silk, and that for the finest purposes to which jute is applied it would sell very readily in large quantities at £25 to £30 per ton, with "good" to "fine" jute at £16 to £25 per ton. It was recommended that the cultivation of this plant should be encouraged.

Dregea volubilis.—A specimen of the fibre from this plant, submitted with reference to its suitability for the manufacture of explosives, was badly cleaned and contained adherent woody tissue. The fibre is non-lignified and, if carefully prepared, could probably be used for the purpose mentioned.

Marsdenia tenacissima.—A specimen of the stems and young shoots of *Marsdenia tenacissima*, grown in Rajmahal, was received from the Director of Agriculture, Bengal. It was suggested that for information with regard to the properties and value of the fibre reference should be made to the "Bulletin of the Imperial Institute," 1903, 1, 121.

Wool.—Samples of wool yarn and patti from the Central Jail, Coimbatore, were examined. One specimen of wool was of a fixed and irregular type and worth about 10*d.* to 1*s.* per lb.; the other was valued at only 6*d.* to 8*d.* per lb. on account of its brown colour. Recommendations were made with reference to breeding. The yarn and patti were unsuitable for export to the United Kingdom.

Flax dodder.—In reply to a request from a firm of planters for information with regard to *Cuscuta Epilinum*, the flax dodder, which was said to be attacking flax plants in India, a memorandum was supplied giving the particulars required.

Calotropis gigantea.—In reply to an enquiry from a commercial

firm with reference to the quality and value of the bast fibre of *Calotropis gigantea*, it was pointed out that this fibre is unlikely to assume commercial importance owing to the difficulties of preparation, the lowness of yield, and the shortness of the ultimate fibre. The attention of the enquirer was directed to the seed-floss of this plant as being of some value.

Masulipatam carpet.—An enquiry, accompanied by a sample, was received from a technical institute in Humburg asking for information with respect to the materials of which Masulipatam carpet is composed. The sample was examined and the required particulars supplied.

OILS AND OIL-SEEDS.

A sample of the oil of *Amoora Rohituka* was examined and the results were compared with those yielded by previous samples. The oil appears to be of a somewhat variable character, but could probably be used for soap-making.

A specimen of oil-seeds was received from a firm of merchants with a request for information with reference to its identity and the properties and uses of the seed and oil. The seeds were recognised as the product of *Melia Azadirachta* ("Margosa" or "Neem" fruits) and the required particulars were supplied.

Samples of the fruits, seeds and fats of *Bassia longifolia*, *B. latifolia* and *B. butyracea* have been received and are being examined with reference to the yield and properties of the fats.

TANNING MATERIALS AND DYES.

Symplocos spicata.—A preliminary report on the leaves of this plant has been forwarded to India, showing that it contains a mere trace of a glucoside and appears to be of little or no value as a dye.

Mangrove Cutch.—In continuation of the enquiry on the commercial value of extracts made from the bark of *Rhizophora mucronata* at the tanning extract factory at Rangoon, comparative analyses of this material and of mangrove cutch as exported from Borneo were made, and it was found that the Indian material, though slightly richer in tannin, was far darker in colour and yielded a harsher leather than the Borneo product.

Cæsalpinia digyna pods.—Some correspondence with reference to this product has taken place during the year, mainly with a view to ascertaining whether the husks of the pods can be put on the market in this country, and a number of samples have been received. So far, however, it has proved impossible to obtain the pods in large enough quantity and at a low enough price to interest likely consumers in this country.

TURPENTINE OIL.

Considerable progress has been made with this enquiry, and an interim report on the composition of the oil is now in preparation.

RESINS.

Large samples of the colophony and turpentine of *Pinus longifolia* and *P. excelsa* have been received; their preliminary examination has now been completed and an interim report on this work is being prepared. The chemical examination of the constituents of the resin in comparison with the colophony of commerce is also being continued.

A sample of black dammar resin was tried as a substitute for shellac in crepe finishing, but proved to be not quite suitable for this purpose.

CYANOGENESIS IN PLANTS.

This investigation has been continued, on the lines indicated in last year's report, in consultation with the Board of Agriculture. The results of analyses of a number of samples of Burma beans as sold in this country were given in a paper by Professor Dunstan and Dr. Henry, published in the "Journal of the Board of Agriculture" (1908, XIV, 722). These show that the amount of prussic acid obtainable even from white Burma beans may vary within somewhat wide limits. It was suggested that feeding trials with Burma beans and other products capable of yielding prussic acid should be instituted in order to ascertain whether the continued use as feeding-stuffs of products yielding small quantities of prussic acid exercises any injurious action on cattle. This investigation has acquired further interest recently owing to the occurrence in this country of several poisoning cases among cattle alleged to be due to the use of linseed cake.

TIMBERS.

At the suggestion of a firm of match-makers, samples of woods likely to be suitable for match-making were obtained from India, and were submitted to the firm for trial. They reported that none of the samples supplied was suitable for this purpose.

Samples of boxwood forwarded for valuation were submitted to experts, who valued them at £3 10*s*. to £5 per ton, but stated that the timber would probably be difficult to sell in this country and that the price it would bring would probably not be remunerative to exporters.

TOBACCOS.

Samples of tobaccos sent by the Director of Agriculture, Bombay, are under investigation.

MINERALS.

Pottery Clays.—A report giving the results of firing tests with a large number of Indian clays and analyses of a selected few of these has been sent to the Officiating Reporter on Economic Products. In addition requests for information as to the occurrence of various minerals in India have been received and samples of a number of minerals from India have been submitted by commercial firms for identification and valuation. The most interesting of these were samples of plumbago, mica and samarskite.

MISCELLANEOUS.

Cow-dung Cakes.—A sample of this material was forwarded by the Director of Agriculture, Bombay, with the request that its manurial and calorific values might be determined. The results of the analysis showed that the product contained much mineral matter and was of very low manurial value.

The following rep orts have been forwarded to India during the year :—

Report on Cotton from Burma.

„ Agave and Furcræa Fibres from Hindupur, Anantapur, Madras.

„ *Ficus elastica* rubber from Mukkie.

„ Agave fibre from Assam.

Report on Pottery Clays.
" Indian timbers for the manufacture of matches.
" Black Dammar resin, *Canarium bengalense.*
" Colouring properties of leaves of *Symplocos spicata.*
" *Ficus elastica* rubber from North Arakan.
" *Amoora Rohituka* oil.
" Cow-dung cakes.
" *Manihot Glaziovii* rubber from South Arcot, Madras.
" Fibre from the stem of *Dregea volubilis.*
" Development of Trade in Indian Medicinal Opium.
" Boxwood.
" *Marsdenia tenacissima* fibre from Rajmahal.
" *Sida rhombifolia* fibre from Bengal.
" Three-cotton and seed from Sambalpur.
" Comparative tanning values of Rangoon mangrove extract and Borneo Cutch.
" Wool, yarn and patti from the Central Jail, Coimbatore.
" *Cæsalpinia digyna* pods.
" Inga fruit from Baroda.
" Wild cotton from Tenasserim River, Mergui.

The following articles dealing with subjects of special interest to India have been printed in the "Bulletin of the Imperial Institute" during the year:—

Tanning Materials from India, the Colonies, and other sources . . . . . 1907, V, 343.
Para rubber from Mergui, Burma . . . 1907, V, 371.
Cryptostegia grandiflora rubber from India . 1907, V, 371.
Jute substitutes from the Nyasaland Protectorate . 1907, V, 374.
Teas from Natal . . . . . 1908, VI, 1.
Cottons from India . . . . . 1908, VI, 11.
Rubber of *Ficus elastica* from India . . . 1908, VI, 22.
Uses, properties, and production of gums . . 1908, VI, 29.
Weight as a factor in Seed Selection, with special reference to Cotton . . . . 1908, VI, 74.
Use of dried Cow-dung as fuel in India . . 1908, VI, 88.
Jute and Jute substitutes from West Africa . . 1908, VI, 126.
Production and utilisation of Wattle Bark . . 1908, VI, 157.
Fibre of *Sida rhombifolia* from India . . . 1908, VI, 211.
Mineral Production of India . . . . 1908, VI, 215.

Cultivation and Marketing of Maize . .	. 1908, VI, 261.
International Rubber Exhibition in London .	. 1908, VI, 277.
Experiments in Jute Cultivation in Bengal .	. 1908, VI, 292.
Export of Tanned Skins from India . .	. 1908, VI, 319.

Summaries of the contents of the principal Indian publications relating to economic products are now being published regularly in the Bulletin, as they appear, see "Bulletin of the Imperial Institute", 1908, VI, Nos. 2 and 3.

The above statement of the work conducted on Indian materials refers to the samples of those which have been received from India, and does not include enquiries which have been dealt with at the request of the India Office or of the India Store Depot.

INDEX.

B

Page.

C

D

E

Page.

F

G

L

M

N

O

T

Departmental Publications.

I.—Department of Economic Products.

(1) The Agricultural Ledger—a series of papers on Economic Products issued as ready and priced according to the number of pages.
(2) Commercial Circulars printed for circulation but not on sale.
(3) Annual Report of the Industrial Section, Indian Museum.

II.—Meteorological Department.

Government of India Office.

(1) The India Daily Weather Report and Chart.
(2) The Weekly rainfall summary.
(3) The Monthly Weather Review.
(4) The Annual Summary.
(5) The rainfall of India.
(6) Indian Meteorological Memoirs.

Bengal Office.

(1) Bengal Daily Weather Report and Chart.
(2) Monthly rainfall tables and summaries of the chief features of the weather of the month over Bengal.

Bombay Office.

(1) Bombay Daily Weather Report and Chart.
(2) Monthly abstracts of the Bombay observations (Bombay Gazette).

Madras Office.

(1) Bombay Daily Weather Report and Chart.
(2) Monthly rainfall tables (Madras Gazette).

Allahabad Office.

(1) Monthly Weather summaries (United Provinces Gazette).
(2) Annual summary.
(3) Monthly rainfall tables (United Provinces Gazette).

Lahore (Simla) Office.

(1) Monthly Summary
(2) Annual Summary
} of Punjab weather.

III.—Geological Survey.

The publications of the Department include—

Palæontologia Indica arranged in series, and sold in parts which are priced at 4 annas (6 pence) per plate.

Memoirs, Vols. I—XXXVI, including the larger papers on geological subjects.

Records, Vols. I—XXXII, including the shorter papers and Annual Reports from 1868 to 1904 sold in parts, price one rupee each.

Manuals, Guides and Maps.

A complete list of the contents of these publications can be obtained by application to the Registrar, Geological Survey of India, 27, Chowringhi Road, Calcutta. Indexes to the Genera and Species described in the Palæontologia Indica up to 1891, to the Memoirs. Vols. I—XX, and to the Records, Vols. I—XXX, have been printed for sale.

IV.—Survey of India.

(1) Annual General Report.
(2) Professional Papers.

V.—Botanical Survey and Royal Botanic Garden, Calcutta.

(1) Annual Report of the Botanical Survey of India.
(2) Records of the Botanical Survey, Vols. I—III, and Vol. IV, Nos. 1—3.
(3) Annual Report of the Royal Botanic Garden, Calcutta.
(4) Annals of the Royal Botanic Garden, Calcutta, Vols. I—X.

VI.—Department of Agriculture.

(1) *Annual Report.*—An account of the year's work of the Imperial Department, including the separate reports of the scientific officers of each branch (Agricultural Chemistry, Botany, Mycology, Entomology and the like).

(2) *The Agricultural Journal of India.*—A quarterly journal containing articles on agricultural matters intended for the educated agriculturist and the general reader interested in Agriculture.

(3) *Scientific Memoirs of the Department of Agriculture.*—An occasional publication for papers of a scientific or technical nature divided into series such as Chemical, Botanical, Entomological, and the like.

(4) *Bulletins.*—An occasional publication containing information on agricultural matters of a temporary nature.

(5) *Leaflets.*—Short notes of practical instruction in agricultural matters, dealing mainly with entomological subjects.

VII.—Forest Department.

(1) *Review of Forest Administration in British India* by the Inspector-General of Forests (issued annually).

(2) *Annual Progress Report of Forest Administration in each Province.* Issued by the Local Governments annually.

(3) *The Indian Forester.*—A monthly Journal of Forestry, Agriculture, Shikar and Travel. This is a Departmental Journal published monthly.

(4) Bulletins are published from time to time.

VIII.—Zoological Department.

(1) Annual Report.

(2) Monographs, appearing at irregular intervals.

IX.—Civil Veterinary Department.

(1) Annual Report.